Introduction

Sciences abound with general statements describing regularities in the natural world that have been given the status of laws by scientists. Many more such statements are said by philosophers of science to be laws. Famous physical laws like the laws of Newtonian mechanics and Maxwell equations governing electromagnetism constitute the former, and statements like “fermions have half odd integer spin” and even “ravens are black” constitute the latter, which is more inclusive. What motivates bringing all these statements under the title “law” is the role they play in scientific explanation and predictions on the one hand, and the fact that they are all considered to be true lawlike generalizations, on the other hand, where being a lawlike generalization, as opposed to an accidental one, amounts to being an unrestricted, modally robust, universal generalization. Granted all these statements are law statements, a genuine question to ask is: what do they express? What are the logical form and truth-conditions of law statements?

Philosophers often begin the analysis of law statements by proposing the logical empiricist schema that suggests all law statements can be homogenously analyzed as universally quantified conditionals. The suggestion gains its plausibility from the Humean idea that laws are nothing but constant conjunctions of the regular events observed in the world. However, this account faces various difficulties and has been challenged by many philosophers. The opposition to the logical empiricist account can be grouped in two camps. On the one hand, there are those who accept laws as being lawlike generalizations in the sense of being universal, conditional, and modally robust and provide alternative logical form and semantics for the recalcitrant, restricted cases. (Pietroski and Rey 1995; Schurz 2002, 2005; Reutlinger 2011; Huttemann 2014) On the other hand, there are those who aim for a redefinition of what counts as a law (Cartwright 1999; Giere 1999; Earman 1986; Lange 1993, 2009; Mitchel 1997, 2000; Faye 2005). Since my aim in this thesis is to study statements of the laws from a logical and linguistic perspective, I will mostly engage with the former group.

The former group grant the assumption that lawlikeness can be captured syntactically and/or semantically and set to provide competent logical representations of law statements. Most accounts in this group distinguish between exceptionless laws of exact sciences (such as physics) and the laws of special sciences (such as biology) that are true in spite of there being exceptions to them. These accounts contend that laws of exact sciences can be captured as modalized universally quantified conditionals, and claim that other non-universal or restricted laws, particularly those of special sciences, are laws which must be accompanied by a set of conditions that would block the laws' falsifiers, that is, laws which are true given these conditions hold. These accounts aim to provide a non-trivial semantics for laws that require such a set and are often called ceteris paribus laws or CP laws.

One particular approach in this camp, which I am sympathetic with and will follow in the present work, is the proposal that the proper way to address the puzzle of law statements is to understand them as generic generalizations (Drewery 1998, 2005; Nickel 2010; Claveau & Girard 2019). Most of these account, however, restrict their proposal only to CP laws and do not enter the realm of exact sciences. The only exception that I know of is Drewery who argues that all law statements should be taken to be generic generalizations. However, her account shares the common assumption that law statements are semantically homogenous. The only difference between law statements is that those which belong to exact sciences are exceptionless, while others admit of exceptions, a difference that a unified semantics for generics can account for. This is the assumption that I want to challenge in this thesis.

In this thesis, I will argue that law statements are not semantically homogenous. I contend law statements can be divided in two general types: definitional law statements and descriptive law statements. The statements of each of these two types are different in that the former are analytic statements, while the latter expresses nomological dispositions. Interestingly, it has been argued that the same distinction exists between generic generalizations. (Burton-Roberts 1977; Greenberg 2003; Krifka 2012) These scholars contend that there is substantial semantic difference between definitional and descriptive generics. I will take this as another evidence that while other accounts have difficulty accounting for the semantics of law statements, generics provide us sufficient semantic tools to make sense of what law statements mean and their differences.

Regarding the semantic theory of generics, I will focus here on Krifka's and Greenberg's accounts. I will argue that while Greenberg's account of definitional generics has some shortcomings, Krifka's account successfully captures the analyticity of definitional generics. On the other hand, while Krifka's account of descriptive generics has difficulty making sense of some problematic generics, Greenberg's theory provides a powerful account of descriptive generics. Given these observations, I will propose a synthesis of the two theories, and suggest a semantics for generic generalizations that can both account for various previously known generics and law statements as generic generalizations.

Throughout this paper, I will confine myself to laws of physics. Since physics is considered to be the most exact science whose laws are the exemplars of the mainstream analysis, if I succeed in making my proposal plausible, it can be easily extended to other exact sciences and less exact special sciences as well. The structure of my thesis is as follows.

In section 1, I will distinguish between two general types of laws, namely, definitional laws and descriptive laws. The laws of each type differ both in their modal power and what they mean. In section 2-1, I will introduce the classic logical empiricist analysis of law statements, which I call the standard schema, and point to its weaknesses in accounting for differences between law statements and their semantics, and in this way, attempt to make clear what a proper account of law statement should cover. In 2-2, I will argue that law statements should be understood as generic generalizations, and show how the characteristics of generics matches the characteristics that a proper account of lawlike generalizations must have. In the last section, I will propose an analysis of generics, and consequently law statements, based on the works of Krifka and Greenberg. In 3-1, I will introduce Greenberg's in-virtue-of theory of generics and criticize it as an adequate account of definitional generics. In 3-2, I will introduce Krifka's account of definitional and descriptive generics, and while I keep the analysis of definitional generics as proposed by Krifka, I will argue that it cannot provide correct analysis for some generic generalizations, including absolute minority and dispositional generics. In 3-3, I argue that the IVO theory can be used to successfully deal with descriptive generics, particularly the problematic generics that Krifka's theory has difficulty accounting for. Lastly, in 3-4, I will show that the analysis I propose for generics can be used as an account of what law statements mean.

1. Definitional and Descriptive Law Statements

There are several ways to distinguish between different types of laws in physics and other sciences. Such distinctions determine the hierarchy of fundamentality in laws, or whether the laws establish relations between quantities or qualities. In other words, these distinctions aim to distinguish between laws ontologically[1]. The conceptual assumption underlying the statements of the laws of each of these classes, however, is that all law statements, regardless of the class they fall under, can be considered as instances of a single law archetype and be given uniform analysis. I believe this assumption leads to an insufficient analysis of law statements because, firstly, it neglects the difference in lawfulness of various law statements, and secondly, it disregards the difference in their modal force.

Consider difference in fundamentality as an example. Laws are often divided into fundamental laws and derived laws. Fundamental laws are the most basic principles governing the world and are often taken to be the most basic laws of physics. A derived law, then, is any lawlike generalization that can be derived from a set of more fundamental laws (Johansson 2005: 156) This distinction, however, leaves the differences between fundamental laws themselves untouched. Consider this example: the translational symmetries are considered to be more fundamental than the Newton's laws of motion and the laws of motion more fundamental than the law of simple harmonic motion. However, there are more differences between these laws than their place in the hierarchy of fundamentality. The way that translational symmetries are more fundamental than laws of motion is different from the way that laws of motion are more fundamental than the law governing simple harmonics. The translational symmetries are constraints on the working of the whole physical world, while the second are laws that govern Newtonian systems, and the third a pattern of regularity in a particular instantiation of a Newtonian system.

Moreover, there is difference in the modal force of law statements (Tahko 2015; Hirèche et al.2021) that cannot be read off the fundamental/derived distinction. For example, the way that Pauli Exclusion Principle (PEP) is necessary is different from the way that the simple harmonic law is necessary. While the latter is only nomologically necessary, the former is analytically necessary, and this cannot be captured by saying that PEP is more fundamental than the simple harmonic law, since difference in fundamentality is a matter derivability, and it does not automatically say anything about difference in necessity. Therefore, I believe an

[1] For an overview of the classifications of laws see Friedel Weinert (1995).

account is needed to show us, more than the hierarchy of fundamentality, the structural difference between laws.

In this section, I will propose a different way of distinguishing laws which has significant consequences for the lawhood of the laws in physics and would serve as a guide in deciding which theory best accounts for the logical form and semantics of law statements. I will argue that law statements can be divided into definitional and descriptive laws statements, and each of these two require a different analysis.

Let us begin by the laws that physicists consider as laws, such as Newton's second law and conservation laws. There is a prevalent distinction between laws in physics that is guided by the roles scientists expect each law to play in a theory. The distinction is between kinematic laws and dynamic laws. Curiel (2016) suggests that every physical theory has two parts: one part deals with the evolution of a system over time and space under the influence of external factors and the other part with fixing the properties and the space of the possibilities of a system regardless of all external influences. The former is called the theory's dynamics and the latter its kinematics. Kinematics, then, is that part of a theory that determines the most basic properties and relations between quantities which would specify what kind of a system the theory deals with. Hence, kinematical laws are those that define systems that a theory can be successfully applied to. Let us make this clearer using two examples taken from Curiel (2016).

Consider these two statements from Newtonian mechanics and Maxwellian electromagnetic theory:

(1) a) $\mathrm{v} = \frac{dx}{dt}$ (the velocity component of Newton's second law)

b) $\nabla \cdot \mathrm{B} = 0$ (Gauss's law for magnetism)

The statements (1a) says that the velocity of a moving particle is equal to the rate of its spatial displacement over time. This is a very strong statement: no matter what environment the system is located in and regardless of the external influence, it would hold. It is not the case that (1a) holds if Newtonian mechanic holds, but the other way around: for Newtonian mechanics to make sense (1a) must hold. Therefore, (1a) is a constraint that defines (partially) the system we are dealing with (as opposed to other systems that would be defined by constraints of angular or phase velocity).

Velocity is a fundamental concept in classical kinematics, hence it can be readily accepted that (1a) is definition fixing the meaning of the concept. The case of (1b), however, is more interesting. The statement (1b) says that the net magnetic flux through a closed Gaussian surface is zero. This equation, like (1a), holds regardless of the evolution of an electromagnetic field. Gauss's law for magnetism says, in a formal manner, that magnetic monopoles does not exist. Therefore, the statement is a constraint on what is to be considered a magnetic field. If (1b) fails, it means that we are not dealing with Maxwellian electromagnetic system, and hence the whole theory fails as a proper theory for treating the phenomena. It is clear now that the statements in (1) kinematical constraints which are independent of the evolution of their related systems and set up the preconditions which must be satisfied before a theory can treat a system.

The role that kinematical constraints play in a theory is that of system characterization. This means that for a model to be appropriately about or represent a physical system, it must firstly completely satisfy all the kinematical constraints that characterize that system. Curiel says about the kinematical constraints that:

> Theories do not predict kinematical constraints; they demand them. I take a prediction to be something that a theory, while appropriately modeling a system, can still get wrong. Newtonian mechanics, then, does not predict that the kinematical velocity of a Newtonian body equal the temporal rate of change of its position; rather it requires it as a precondition for its own applicability. It can't "get it wrong". If the kinematical constraints demanded by a theory do not hold for a family of phenomena, that theory cannot treat it, for the system is of a type beyond the theory's scope. (Curiel 2016: 6)

Therefore, the statements of the kinematical constraints are the most basic statements of a theory without which the theory becomes meaningless. Being the most basic, constitutive parts of a theory, kinematical constraints cannot be given truth-conditions relying on anything other than what they themselves define. Thus, as Curiel (2016: 9) mentions, statements of kinematical constraints are "analytic," conceptually necessary statements. The law statements that fall under the class of kinematic constraints share the same characteristics: such laws are analytic, conceptually necessary laws that define systems and I call them definitional laws.

Definitional laws of this type are not limited to those like (1b) that relate physical quantities. Consider the following statements:

(2) a) The total energy of an isolated system remains constant. (Law of Conservation of Energy (CE))

b) Identical fermions do not occupy the same quantum state in a quantum system at the same time. (Pauli Exclusion Principle (PEP))

The statements in (2) have the two principal features of kinematical constraints, namely, they are invariant with respect to spatio-temporal specifications of their respective system and they characterize those systems. If (2a) falls, almost all our current physical theories would fall, since they are based on the precondition that they are about systems that have time translation symmetry, and this is exactly the condition that CE sets. Similarly, a quantum system that does not observe PEP, is simply not a system consisted of fermions since the PEP sets the constraint that the total wave function for fermions is antisymmetric, and if PEP fails, it means the total wave function is symmetric, which consequently means that the system is consisted of bosons. It follows from being a system consisted of fermions that the system observed PEP; it is imbedded in being a time translation symmetric system that the energy is conserved in the system. Therefore, conservation laws and fundamental principles like PEP are kinematical and thus definitional in the sense I mentioned earlier.

The kinematical laws presented above are put against dynamical laws, which govern the evolution of systems over time and space. While kinematical laws, as we have seen, characterize physical systems, dynamical laws individuate systems with respect to their initial condition and environment. Consider the simple case of Newton's second law:

(3) F = ma

Unlike the kinematical laws we saw, the state that (3) is about is completely dependent on the environment in which the system is situated, that is, the state of the possibilities of the system is not fixed and is dependent on the specification of forces involved (whether the force is gravitational, frictional, etc., or a combination of them will change the way the system would evolve from a state to another). Thus, given the forces involved in a system are specified, Newton's second law will tell us what possible states the system can evolve into.

While the kinematical laws are definitional, one may expect the dynamical laws to be descriptive, since they seem to describe the evolutional path of a system. However, in order for a statement to have descriptive content, the terms that appear inside it must be well-defined independently of the statement itself. Consider (3) again. Since acceleration is derived velocity (dv/dt), and since it is a precondition of Newtonian system that it satisfies the kinematical constraint on velocity (v=dx/dt), it can be concluded that acceleration is well-defined independently of the statement (3). What about mass and force?

One may say that mass, as the quantity of matter, is an observable quantity, and hence well-defined. However, we do not have any definitions for force independently of theoretical statements like Newton's second law and law of universal gravitation. This has led, for example, the French mathematician and physicist Henry Poincaré to claim that Newton's second law should not be regarded as "an experimental law" but a definition. (Faye 2005: 82) In this way force is defined by (3), and then the law of gravitation is an experimental law describing the interaction of massive objects. However, as Johansson (2005) rightly mentions, this is completely arbitrary. There is nothing inherently more basic or fundamental in the second law that would justify choosing it as the definition of force over law of gravitation. To complicate matters further, there are people, like Cartwright, who believe that the only real force is the net force in the second law and component forces like the force in the law of gravitation are theoretical constructs, and this supports the idea that if one these statements has to be definitional, it should be the law of gravitation.

The undecided point where we arrived at in the previous paragraph was guided by the assumption that mass is an observable and well-defined quantity. However, the only definition of mass we have, independently of theoretical statements like (3), is that of the standard prototype of the unit of mass kept in Paris. But how did we come up with the international mass prototype? It has been done by weighing, and weighing cannot be made sense of without presupposing Newton's second law or law of gravitation. So what is observable is weight, not mass. Mass is a theoretical concept postulated by a scientific theory, like Newton's mechanics, and cannot be made sense of independently of the statements of the theory (in this case Newton's second law and Universal gravitation) in which it appears.

This suggests that both of these laws are definitional, and the suggestion gains more justification if one takes into consideration the fact that we have seven different definitions of mass, each defined with respect to the theory in which they appear. Therefore, mass and force are jointly defined by a combination of law statements that postulate them: for example, Newton's second law and law of gravitation jointly define classical mass and force as resistance to acceleration and source of change in motion, and statements of general relativity define them in terms of curvatures in space-time. I conclude that dynamical laws like Newton's second law are statements that define postulates of a theory, and hence are definitional law statements.

Not all dynamical laws, however, are definitional as argued for Newton's second law. There are dynamical laws that presuppose the definitions set by the two previously introduced types of definitional laws and describe an instantiation of a system defined by them. Consider the following statement:

(4) F = -kx (Hooke's law for a simple harmonic)

The statement (4) governs the motion of a mass attached to a string. In (4), "x" stands for displacement, which is a fundamental quantity; "k" stands for the spring constant, which is obtained empirically as a measure of the spring's stiffness and must obey the kinematical constraint that requires it to have physical dimension m/t^2; and F is the restoring force and its definition can be given by Newton's second law. As can be seen, all the components of the statement (4) are well-defined independently of the statement itself, and there is no definitional relation between them. Using (4), one can describe and predict the state of any system that resembles the motion of mass attached to a spring, a simple pendulum, a vibrating spring, a massive object bouncing linearly, and many more. Thus, what (4) does is that it makes a generalized model, on the basis of the system defined by the theory, which can describe many instantiations of that system.

It can be readily seen that this type of law statement is modally much less strong than previous ones. While the definitional laws are conceptually necessary, the laws of the descriptive type which rely on empirical facts in the world (like the stiffness of the string in Hooke's law) are nomologically necessary within their established limits (in this case, so far as the system is Newtonian and proper stiffness can be attributed to the string, that is, the string is not very elastic, the temperature is not such that it drastically changes the value of 'k', and so on).

The laws that we talked about so far cover most of the law statements one comes across in physics that scientists themselves call laws. However, there is another type of statements that are often considered to be statement of laws: those that state general empirical facts. Consider these statements:

(5) a) Water boils at 100°C.

b) Metals conduct electricity.

c) All uranium spheres are less than a mile in diameter.

These statements are neither definitional nor descriptive of a system. Yet they are all true generalization describing natural phenomena and are understood as expressions of laws of nature. What makes these statements a law is that they are not accidentally true, and there is something lawful about their truth. The sentences in (5) belong to a general sort of sentences that express a statement of the form “Ps are Qs”, where P is a kind term and Q is a property that members of P are disposed to have in virtue of a certain more fundamental property or principle that governs their internal behavior. For example, (5a) says that water tends to change phase when heated under certain condition, and this tendency is no accident since water has this tendency because of its molecular structure. The same can be said about (5b) and (5c) with respect to the atomic structure of metals and the critical mass of uranium respectively. These statements, then, are descriptive, like the descriptive dynamical laws, but they are not directly related with systems, unlike them. These statements are descriptive of kinds, not systems.

The types of laws that I have considered above covers almost all the statements that are called laws in physics. I argued that there is an important difference between these law statements: while some are descriptive, a significant number of law statements are definitional. This shows that law statements cannot be given a homogenous semantics, since they mean different things. The problematicity of giving a unified account of semantically heterogeneous laws has been also noticed by Giere (2006: 70-71) and motivated him to drop the laws-talk altogether. While I keep silent on the metaphysical status of laws here, I propose that so far as we are using the label ‘law’ to refer to different scientific statements, we need to acknowledge that we need different semantics for them which goes beyond the idea of universality (exceptionlessness and CP universality both).

In the next section I will evaluate the traditional analysis of the logical form and semantics of law statements and show its shortcomings in accounting for the different types of laws we distinguished in this section. Then, I will propose an alternative for the logical form of laws, and on the basis of this alternative I will propose semantics for law statements in the last section.

2 The Standard Schema vs. The Generic Schema

It is widely accepted, since Goodman (1954), that a generalized statement expresses a law if it is lawlike and true. Logical empiricists, who were after laws that could be used to deductively explain physical phenomena, related lawlikeness to a set of conditions that a generalization must satisfy in order to be able to play the role specified for laws. Molnar (1969) summarizes these conditions as follows:

> p is a statement of a law of nature if and only if:
> (i) p is universally quantified
> (ii) p is omnitemporally and omnispatially true
> (iii) p is contingent
> (iv) p contains only non-local empirical predicates, apart from logical connectives and quantifiers. (Molnar 1969: 36-37)

These conditions set the assumptions for the classical empiricist first-order logic schema for law statements "$\forall x\ (Fx \rightarrow Gx)$." I will call this the standard schema. There are several shortcomings with this schema and it has been criticized by many. However, some form of the standard schema with some modifications still appear in the literature. For example, Pietroski and Ray's schematic suggestion for the logical form of law statements is '$\forall x.[F(x,t) \Rightarrow \exists y.[G(y, (t+\varepsilon))]]$ (Pietroski and Ray 1995: 82), which clearly fits in the general form of the standard schema; Friend (2016) also adopts the standard schema as a convenient way of representing law statements. Hüttemann (2014) accepts the standard schema for the fundamental laws of physics and analyses 'CP, As are Bs' as "For all x, if Ax, then (either Bx or there exists an independently confirmable factor that explains why ¬Bx).

Having these examples, I believe that looking more closely at the shortcoming of the standard schema has two benefits: firstly, we can see why the accounts of law statements that incorporate some form of the standard schema run into problems, motivating a search for an alternative approach, and secondly, such criticism guides us about what requirements an alternative account of law statements should meet.

In what follows, I will discuss the shortcomings of the standard schema and then propose and argue that law statements are best captured as generic generalizations.

2.1 The Shortcomings of the Standard Schema

Let us begin with first shortcoming of the standard schema. I argued in section one that law statements fall in two broad classes of definitional laws and descriptive laws. My claim is that the standard schema can capture the difference between these classes neither syntactically nor semantically. According to the standard schema law statements have the general form "all Fx are Gs." It is immediately clear that syntactically no difference can be revealed between definitional and descriptive statements. A simple example can show this easily. Consider these statements:

(6) a. All bachelors are unmarried men.

b. All modern coins are metallic.

There is a one-to-one syntactical correspondence between (6a) and (6b), yet the former is an analytic truth, and the latter is a true description of the state of coins in the modern world.

Regarding semantics, the standard schema establishes a relation between a reference set, Fs, and an attribute set, Gs, such that every member of the set of Fs is also a member of the set of Gs. Now consider two of the law statements we saw earlier, namely, the Pauli Exclusion Principle and metals' conductivity:

(7) a. Identical fermions do not occupy the same quantum state in a quantum system at the same time.

b. Metals conduct electricity.

Considered within the framework of the standard schema, (7a) says that every two member of each sub-set of the set of identical fermions[2] are members of different sets of quantum states at each moment in time. The statement (7b) says that every member of the set of metals is also the member of the set of things that conduct electricity. While both of these truth conditions renders their respective statement true, they fail to capture the deep difference between the two statements, namely, that one is a definitional (analytic) sentence and the other descriptive. What (7a) does is not establishing a relation between two separate sets but identification of two different expressions. But the same is not true of (7b).

Moreover, there is clear difference in modal force of these two statements. While (7a) is conceptually necessary, (7b) is nomologically necessary. This difference is not captured by the semantics proposed by the standard schema. This difficulty, however, can be addressed by introducing a necessity operator to the logical form of the standard schema, "$\Box\forall x\ (Fx \rightarrow Gx)$",

[2] Fermions of the same kind are identical in quantum mechanics. So, for example, two electron or two neutrons are identical.

and saying the difference can be captured by each of the statements respective accessibility relation. So it seems that every law statement L is actually an elliptical statement for “it is a law that L”, and it is the phrase “it is the law that” that supplies the necessity element. Yet again, it is ambiguous how “it is law that” signifies the specific kind of necessity required by each law statement, unless one specifies the modal force of the term law for each use of the phrase, which seems like forcing the standard schema to match each of its tokens. This, as Maudlin mentions, is not an “informative analysis” (Maudlin 2007: 10).

Let us turn to the second shortcoming, namely, that the standard schema is incapable of differentiating between lawlike and accidental generalizations. A lawlike generalization is a general statement that if true, would state a law of nature. Consider again (7b):

(8) All metals conduct electricity.

This is a true statement, and as I argued in section one, it is a descriptive dispositional law. Now contrast (8) with the following statement:

(9) All the apples on the table are sour.

The statement (9) is also true, because I like sour apples. However, (9) is only accidentally true: I may not have liked sour apples, I may have wanted to try sweet apples, I may have bought no apples at all. This is not the case for (8). Statement (8) is lawlike in the sense, which is widely accepted after Goodman (1955), that it supports counterfactuals: if this piece of material was metallic, or if this piece of metal had been subjected to an electrical current, it would have conducted electricity.

Again, it seems that there is no syntactic difference between (8) and (9), hence the distinction cannot be captured on the basis of syntax. So far as we follow the standard schema, it also seems that there is no semantical element that could distinguish the lawlike statement (8) from the accidental generalization (9), since both, if read as first-order logic universal quantifications, are saying that all the members of the reference class are also members of the attribute class. Yet this does not specify the modal status of the membership relation, with which one can explain why one supports related counterfactuals and other does not. Therefore, the lawlike statement (8) cannot be understood as expressing a first-order logic universal quantification.

Finally, let us turn to the third shortcoming, namely, that the standard schema renders many law statements as either false or vacuously true. It has been argued by many philosophers that law statements as universally quantified generalizations about actual things in the world are false, since most laws are either idealizations or approximations. Cartwright (1983) famously argued that all laws of physics, if taken as having empirical content, lie. The same concern has led Giere (1988) to claim that laws are not about things in the world but about things in models. I do not want go through the arguments proposed by these philosophers, but there is a lesson that we can take here which I have already pointed to in my discussion so far, namely, that extensional language of the standard schema is not appropriate to capture the essence of law statements. In what follows I will make this clearer by showing various difficulties that the standard schema causes in this regard.

Firstly, many law statements seem to stand in need of some sort of hedging before we can take them as truthful descriptions of the regularities in the world. This is known in philosophy of science as the problem of provisos, after Hempel (1988). Consider the law of universal gravitation:

(10) $$F = G\frac{m_1 m_2}{r^2}$$

The law states that two massive bodies attract each other with a force proportional to the product of their masses and the inverse square of their distance. However, as a generalization that quantifies over every instance of a system of two masses, this statement is false, since there are countless counter examples to it. The statement (10) leaves out the influence of other effective forces that would affect the dragging force between the two masses. For example, given there is a magnetic field present and the masses are charged, the drag force would not be as predicted by (10). Thus, before one can state (10) as a true universal generalization, one needs to hedge the statement with a set of preconditions (such as absence of an electromagnetic field) that are required to make the statement true. These preconditions are what Hempel calls provisos.

So far provisos seem not to be a serious threat to the truth of the law statements. It can be said that this only tells us that some laws are ceteris paribus laws. The standard schema can be saved, in these cases, by adding a ceteris paribus (CP) phrase to the law statement, where the CP phrase sets all the preconditions necessary to render the law true. However, the problem starts to actually become a serious problem when we observe that the set of provisos (the CP phrase) that we have to provide for the law statement is infinite. It is not just the presence of a magnetic field, some other masses, or any other known interference, but also an infinity of all unknown or unexpected interferences (such as, some unknown force, or as Hempel himself suggests, even some magical forces) that should be excluded. But this reduces a law statement like (10) to a statement saying "(10) is true unless it is not," which is a tautology and only vacuously true.

The second difficulty is with those laws that refer to non-existent entities. Consider this example:

(11) An ideal gas's pressure, temperature, and volume obey the relation PV=nRT.

Considered within the framework of the standard schema, (11) is either invalid or vacuously true. If we consider the logical form proposed by the standard schema to have existential import, since there's no such a thing as an ideal gas, the statement (11) fails its presupposition and therefore would not be truth-evaluable. On the other hand, if the standard schema does not require of law statements the existential import, then (11) would be true, but only vacuously true. It is vacuously true because, again, since there are no ideal gases, (11) is true merely due to the fact that there are no members in the reference set (Fs), corresponding to the conditional expressed by (11), that can have F-membership and not G-membership.

In sum, I have argued that the logical form and semantics proposed by the standard schema lacks the resources required for representing different classes of law statements, capturing the difference between lawlike and accidental generalizations, and providing semantics for law statements. This criticism also suggests that a proper analysis of law statements should be able to, firstly, account for the definitional/descriptive distinction and modal robustness of law statements, and secondly, provide resources to deal with the problem of provisos. In what follows, I will propose that a promising alternative analysis of law statements is considering them as generic generalizations.

2.2 Law Statements as Generic Generalizations

Generic generalizations[3], or as some scholars call them characterizing generalizations[4], are a species of general statements that abound in language, both in everyday life and in scientific talk. Generics "do not express specific episodes or isolated facts, but instead report a kind of *general property*, that is, report a regularity which summarizes groups of particular

[3] Henceforth, I will use "generics" to refer to generic generalizations.

[4] There is another type generalized statements associated with genericity, and it is consisted of sentences like "dinosaurs are extinct." The attribute "being extinct" cannot be predicated to any individual member of the kind dinosaurs and is only predicable to the kind itself. Hence, these predicates are called "kind predicates" and the generic statements in which such predication occurs are called "kind predicating sentences." In this section and the next we only deal with the characterizing generics.

episodes or facts." (Krifka et al. 1995: 2) Generics are generalized statements that lack an explicit quantifier and come in three syntactical forms:

(12) a. Lions are predatory cats. (Bare Plural + VP)

b. A lion is a predatory cat. (Indefinite Singular + VP)

c. The lion is a predatory cat. (Definite Singular + VP)

The sentences in (12), despite being different, have a reading available to them[5] according to which a characterizing property is predicated to the members of the kind designated by the bare plural, indefinite singular, and definite singular determiner phrase that is the subject of each sentence. Generics have a number of characteristics that are important for the task I have at hand in this section: they are inherently modalized and express non-accidental generalizations (Krifka et al. 1995; Heim & Krazer 1998; Krazer 2012; Drewery 2005; Greenberg 2003, 2007, 2012); They tolerate exceptions, that is, an apparent counterexample cannot falsify generics; and they independently represent the distinction between definitional and descriptive generalizations (Dahl 1975; Burton-Roberts 1977; Cohen 2001; Greenberg 2003, 2012; Krifka 2012). I will turn to these features in more detail with respect to law statements in the remainder of this section, but before doing that, I will first motivate the adoption of the generic form on the basis of some formal observation about expression of law statements in natural language.

Law statements can be and often are expressed in the general form of generic sentences in natural language. Consider the sentences in (13) stating various laws of physics:

(13) a. Fermions have half odd integer spins.

b. An electron has unit negative charge.

c. Water boils at 100 °C.

d. The distance traveled by a falling body is directly proportional to the square of the time it takes to fall. (Law of Free Fall)

e. Ideal gases are such that their temperature is proportional to their pressure and volume.

[5] The other reading is existential. Read as existential statement, each of these sentences mean a different thing.

f. The net force on a body is equal to the product of the body's mass and its acceleration.

Compare these sentences with those in (12). I mentioned before that there is a reading available for sentences (12a-c) where they are synonymous and express a generalization, saying that the members of the kind lion are predatory cats[6]. The same is true of sentences in (13). They look the same as the sentences in (12) and, while like sentence in (12) there is an existential reading available to them, as law statements, they must be taken to express generalizations. I discussed in 2-1 that this generalization must not be taken to be first-order logic universal generalization. In what follows, I will argue that law statements should be read as generic generalizations. I will do this by showing how the properties of generics can compensate for the requirements that I showed the standard schema fails to satisfy.

One of the problems mentioned for the standard schema is that it cannot capture the distinction between different types of law statements, namely, the distinction between definitional and descriptive laws. Generics, however, have the resources to represent this distinction. This comes from an important characteristic of generics that was first noticed by Lawler with respect to indefinite singular generics (IS generics) as opposed to bare plural generics (BP generics). Lawler says about IS generics that "'indefinite generics seem most natural in definitional sentences, or ones used somehow to identify the nature of the thing specified by the generic by means of properties peculiar to it." (Krifka 2012: 372) To see the peculiarity of IS generics, consider these sentences:

(14) a. Madrigals are polyphonic.

b. A madrigal is polyphonic.

c. Madrigals are popular.

d. #A madrigal is popular.

The property of "being polyphonic" can be successfully attributed to the musical form madrigal using generic predication with both an indefinite singular and a bare plural subject, yet the same is not true with the property "being popular" and indefinite singular generics. The

[6] There are other theories, known as kind predication theories, according to which in sentences 5a-c the subject DP should be interpreted as denoting the kind itself and the sentence as direct prediction of the property in question to the kind (Carlson 1977; Liebesman 2011). I will ignore these interpretations to avoid complication. However, this would not damage our discussion here because my argument that law statements should be understood as generics is compatible with kind prediction. In fact, since the kinds that science deals with are more fundamental or more natural than kinds one refers to in everyday generics, if kind predication is correct, statements of the laws of nature would be exemplar cases of such predication.

peculiarity is explained by Lawler himself in relation to the observation that (14b) and (14d) seem to claim that something cannot be a madrigal unless it has the property predicated by the sentence, that is, the property in question is somehow defining the kind referred to in the generic sentence. While being polyphonic is a defining property of madrigals, popularity is not. In response to the question what kind of a musical composition a madrigal is, an informative response is that “it is a polyphonic musical composition.” However, responding to that question with “it is a popular musical composition” would not be informative about the kind of musical composition a madrigal is.

Several scholars (Dahl 1975; Burton-Roberts 1977; Carlson 1995; Greenberg 2005; Krifka 2012) worked on the peculiarity of IS generics. Burton-Roberts (1977) associates the peculiarity of IS generics with them being analytic statements. According to him, an IS generic like (14b) has the same meaning as the statement “to be a madrigal is to be polyphonic”. Thus, his claim is that an IS generic establishes a special relation between its subject and predicate which is that of *semantic necessity*. Most recently, Krifka (2012), drawing on the works of Burton-Roberts, distinguishes between generics that are definitional and those that are descriptive. Krifka observes that definionality is not strictly associated with IS generics, though most IS generics are in fact definitional. He considers definitional and descriptive reading as two reading available for generic statements, where the descriptive reading “presupposes that the language is fixed, and is the same for all participants in conversation” and definitional reading “communicates about the language that is being used.” (Krifka 2012: 375) Therefore, Krifka, like Burton-Roberts, introduces the semantic necessity for the definitional generics, though he, unlike Burton-Roberts, does not tie this to the syntax of IS generics.

I will get into more details about Krifka’s treatment of the definitional/descriptive generics in the next section, though I believe this much that is said here is enough to show that generics can naturally capture between the two general class of laws I introduced in section one, that is, the distinction between definitional laws -those that fix systems and their postulates and have conceptual necessity- and descriptive laws –those that express empirical regularities in instantiations of systems or causal dispositions and have nomological necessity.

The second problem mentioned with the standard schema was that it is unsuccessful in capturing the difference between lawlike and accidental generalizations. The primary difference between lawlike and accidental generalizations is that the former but not the latter support counterfactuals. To support counterfactuals, a generalization must be modally forceful, that is, it must go beyond the domain of things in the actual world. In 2-1, I argued that first-order logic universal quantification proposed by the standard schema fails to do this. However, generics are known to be inherently modalized and able to support counterfactuals. Consider these examples:

(15) a. Metals conduct electricity.

b. Dogs bark.

c. Espresso machines dispense hot water.

d. Cats are cute.

On the generic reading, the sentences in (15) express statements of drastically varying force, they range from a statement of a nomologically necessary law of nature, (15a), to a taste-related stereotype. Whether these statements are true or not, and irrespective of how strong or essential the relation between their subjects and predicated properties are, they share something in common: such statements do not pick any limited, actual or local, set of the members of the set denoted by their subject for predication. It is all metals, dogs, espresso machines, and cats that have ever existed, exist, and may come to existence that are subject of the characterizing predication. Therefore, these statements support counterfactuals. If metals do conduct electricity, then even if by some extraordinary universal event there have been no metals in our universe, metal would still conduct electricity; or if cat were cute, then it would be true that had this animal in front of me been a cat, it would have been cute. However, not all generics have unqualified subjects of predication. Consider these examples:

(16) a. Lions have manes.

b. Ducks lay eggs.

Clearly, it is not the case that all lions and ducks are subject of the characterization. It is only male, adult lions, and female, fertile ducks that can be subjects of the generics in (16). However, this does not make any difference in their counterfactual supporting behavior. To settle how sentences in (16) get their subjects fixed for adult male lions and fertile female ducks is task for a semantic theory of generics, but once by whatever mechanism this is fixed, then it would be all such lions and ducks, which have ever existed, exists, or may exist in the future, that are subject of the respective characterizations. The predication is of course true of the subject so far as the principle, phenomenon, or mechanism (the biological structure, the code of conduct, the fact that the statement is a definition in a system, …) in virtue of which such characteristics emerge holds. It is also this in-virtue-of principle, phenomenon, or mechanism (IVP) that determines the intensity and flavor of the modal force of generics, that is, IVP determines whether the statement has conceptual/nomologic/deontic/epistemic possibility/necessity.

Therefore, it can be concluded that generics, unlike the standard schema's formulation, can only express non-accidental generalizations with appropriate modal force and are a viable alternative to the standard schema for law statements.

Lastly, let us turn to the third problem mentioned for the standard schema, namely, that many law statements (specially Ceteris Paribus laws) are simply false or vacuously true when considered as universally quantified statements of the form proposed by the standard schema. The root of the problem is that there are sets of preconditions or interferences that must be defined and added to the formulation of the law statements in order to exclude instances over the domain of quantification which falsify the law, but these sets are indefinite and unidentifiable. I suggest that if we consider law statements as generics, this problem can be addressed by the fact that generics can tolerate exceptions.

Consider these sentences:

(17) a. Ravens are black.

b. Sea Turtles live long.

c. Mammals give birth to live young.

All of the sentences in (17) are true, but to each of them there are exceptions. There are albino ravens, most sea turtles die at birth for various reasons, and there are mammals that lay eggs. However, these counterexamples do not falsify their respective generic sentences. Moreover, to provide truth conditions for a sentence like (17a), one is not required to supply a set of exceptions including albinos, red-painted ravens, genetically mutated ravens, ravens that lost feather for whatever reason, and so on. However, this does not mean that generics cannot be falsified. There is difference, as Nickel (2016) suggests, between those instances that go against the generic statement but are merely apparent exception, and those that are genuine counterexamples to the generic. For example, consider the following sentences:

(18) a. Ravens are white.

b. Books are paperback.

Black ravens, and all sorts of things which we call book and have non-paperback bindings are genuine exceptions, and hence falsifiers, to the sentences in (18) respectively. Why are these exceptions falsifiers? It is because the characteristic attributed by these sentences goes against what, and how, we understand the kind in question. In Nickel's words, "we have and antecedent grasp of the proper conformers to a generic" and we use this more basic notion to differentiate between exceptions and falsifiers (Nickel 2016: 56). Needless to say, that how we should make sense of this prior grasp must be accounted for. I will talk about this more in the next section.

The same goes for law statements. A piece of metal that has its electron localized by some interfering force (a magnetic field, extreme pressure, or a mysterious unknown force) is not a counterexample to the statements "metals conduct electricity." In fact, any instance of metallic insolating behavior is considered an exception due to known or unknown reasons because being an insulator is not a characteristic with which we recognize metals. For an exception to falsify this law, it must change our grasp of what a metal is. Therefore, given the previous grasp of what metal is, "metals conduct electricity" does not need any set of preconditions to be true.

So far I have argued for a big divide between law statement, namely, the divide between definitional and descriptive ones. I argued that the standard schema not only is unable to account for this distinction, but also too weak to distinguish between lawlike and accidental generalizations, on the one hand, and too strong to capture proper truth-conditions for law statements on the other hand. Lastly, I argued that generics have enough resources to address all these shortcomings, since they are able to distinguish between definitional and descriptive generalizations, they support counterfactuals and can represent lawlike generalizations, and they are such that they can account for provisos to generalizations without demanding a complete set of such provisos to be known. Therefore, I propose that a generic schema is a good alternative to the standard schema. In the next section, I will discuss this generic schema in general and with respect to law statements and propose a respective semantics for it.

3 Generic Semantics for Law statements

In the previous sections, I emphasized three aspects of generics, namely, definitional/descriptive divide, modal robustness, and exception tolerance, which I suggest are of much interest for accounting for the meaning of law statements. It is with respect to these three elements that I will pick and further develop an interpretation of generics in this section. As I mentioned in subsection 2-2, the definitional/descriptive distinction came to light after Lawler (1973)[7] discussed the peculiarity of IS generics. Since then, several theories have been proposed to account for the distinction, some of which I mentioned in subsection 2-2. In this section, I will focus on Krifka (2012) and Greenberg (2003, 2007, 2012) works on definitional generics. I chose these two accounts because, on the one hand, they adhere to a modal reading of generics, which, as I argued, is important to capture the essence of law statements, and on the other hand, they endorse a normality account of generics in dealing with exceptions, which I will argue is a potentially resourceful starting point for dealing with law statement provisos.

In what follows, I will begin by introducing Greenberg's in-virtue-of account of IS generics. Then I will discuss the shortcomings of her account in dealing with definitional generics and argue that Krifka's theory is better suited as an account of definitional generics. Moreover, I will argue that Greenberg's in-virtue-of theory is superior to the simple modal interpretation of descriptive generics that is endorsed by Krifka, in that Greenberg's interpretation is able to easily account for troublesome generics such as absolute minority generics and dispositional generics. In light of these observations, I will provide an interpretation of the descriptive generics, amending Krifka's simple modal interpretation with Greenberg's in-virtue-of account. Lastly, I will show that how my proposed semantics makes sense of definitional and descriptive law statements.

3.1 Greenberg and In-Virtue-Of Generics

Given that the logical form of generics is GENx[P(x)][Q(x)], where P(x) is the restrictor part that denotes the kind members to which the generic statement predicates a property, and Q(x) is the scope part that denotes the property predicated, the standard general schema for modal interpretation of generics given by Krifka et al. (1995) is as follows, where W is the set

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[7] My reference is from Krifka (2012). Original reference is: Lawler, John. 1973. Studies in English generics. PhD dissertation, University of Michigan. Published as Studies in English generics. *University of Michigan Papers in Linguistics,* 1:1.

of all possible worlds and w∈W is a possible world in the set, and R is an accessibility relation over possible worlds:

(19) $GEN(x)[P(x)][Q(x)]$

$\forall w'[[w'Rw] \rightarrow \forall x[P(x,w') \rightarrow Q(x,w')]]$

This formulation says that for all worlds that are suitably accessible from the world w, things that are P in those worlds are also Q. Since the accessibility relation in (19) is unspecified, it allows generics to represent all modal flavors (deontic, epistemic, nomic, etc.) which is very desirable, since it makes sense of the use of generics to express legal, ethical, nomological generalizations and provides proper truth conditions for such statements. However, Greenberg (2003) points to a problem that (19) runs into dealing with generics like the following:

(20) A man is blond.

Greenberg's observation is that generics like (20), more than being false, are infelicitous, and while (19) can correctly account for their falsity, it cannot capture their infelicity. The infelicity of generics like (20) has been associated[8] to the fact that IS generics cannot felicitously predicate non-essential or accidental properties. This view gains its force, particularly, from the assumption that IS generics are analytic. Greenberg, however, disagrees claiming that the infelicity of such generics is not related to the non-essentiality of their predicates. On the one hand, one can make felicitous and true IS generics with non-essential predicates. For example:

(21) A carpenter earns very little.

The sentence (21) is obviously not analytic and it does not predicate any essential property of carpenters. Yet, (21) is felicitous and given the state of the carpentry profession it is likely to be perceived as true. Furthermore, even those generics that predicate non-essential properties and are infelicitous, can be made felicitous and true with contextual restriction:

(22) a. #A room is square.

b. In Japan, a room is square.

Therefore, there is no necessary relation between felicity of IS generics and essentiality of their predicates. However, even generics like (21) and (22a), if true, express a law or

[8] For example, by Burton-Roberts (1977).

regulation of some sort. In order to capture the essence of IS generics, Greenberg (2003) introduces an in-virtue-of property (IVO) that a generic must accommodate to be able to express an IS generic. The subject of an IS generic has the property predicated to it in virtue of having the IVO property. In other words, for a generic "a P is a Q", there must be an IVO such that a P's being a Q can be deduced from P's having the IVO. Greenberg's interpretation can be expressed as follows:

(23) $\forall w'[[\forall x[P(x,w')\rightarrow S(x,w')]] \rightarrow [\forall x[P(x,w') \rightarrow Q(x,w')]]]$
where S is the IVO property.

For example, "a dog has four legs" is true in virtue of the genetic makeup of dogs. Greenberg emphasizes that the choice of the IVO property is not arbitrary. She introduces two constraints that a property must meet in order to be qualified as an IVO property.

The first constraint is that the IVO property must be *associated* with the subject of the generic statement. The constrains requires the association between P(x) and S(x) in accessible possible worlds to be dictated by norms, laws, stereotypes, and like these. With this constraint one can block odd, or irrelevant properties like "three-leggedness genetic makeup" from being introduced as an IVO for false generics like "a dog has three legs".

The second constraint that Greenberg introduces is that the IVO must be a *reasonable causer* of the property predicated in the IS generic. The reasonable causation constraint serves to guarantee the felicity of IS generics by insuring that only those predicates can be felicitously predicated in IS generics that there is a valid causal relation between them and an associated property of the subject of the generic. So, for example, (22a) is infelicitous because there is no known associated property of "rooms" that causes them to be square, while (22b) is felicitous because there seems to be such a property, namely, the regulations set by the Japanese cultural conventions for architecture, which is both associated with rooms in Japan and reasonably causes, through Japanese architects, rooms to be square shaped.

What Greenberg's constraints do is setting normality conditions for the subject of characterizing predication with respect to the predicated property. The association condition restricts the possible worlds to only those where an epistemic, conventional, or nomological ground exists for the target predication. Then, the reasonable causation sets the condition for normal possession of the predicated property. Thus a normal generic subject is one that possesses the property predicated where there is a justifiable ground for predication and there is no causal interference. For example, a normal dog with respect to having a certain number of legs is one that has a certain genetic makeup, and that genetic makeup is associated with the kind dog with respect to a nomological-biological ground and causes the possession of a certain number of legs in dogs. Since for the kind dog, with respect to the number of legs that individual dogs possess, it is the four-leggedness genetic makeup that is associated with them, a normal dog is one that has that genetic makeup and has four legs. The exceptions, then, are those individuals that have a certain other property that in some way blocks the associated property or interferes with the relevant causation. So, to present two examples, an exceptional dog with respect to the number of legs it possesses is one that went through a genetic mutation that would block dog's normal genetic makeup, in the sense mentioned, or went through amputation which interferes with the dog's having four legs because of its genetic makeup.

We can see that Greenberg's IVO theory can deal neatly with generics like 'a dog has four legs'. However, not all definitional generics are as straightforward as 'a dog has four legs', and the success of the IVO theory must be measured against trickier cases. Here, I want to argue that IVO theory has two shortcomings that makes it inappropriate as an account of definitional generics.

One problem that has been pointed out by Mari (2008) is that Greenberg's IVO theory runs into problem accounting for those IS generics that have modified subject noun phrases. Consider the example below, which has been taken from Mari (2008: 422):

(24) a. #A leader is dangerous.

b. A violent leader is dangerous.

While (24a) seems wrong, the modified (24b) seems be a perfectly fine IS generic. Cast in Greenberg's interpretation, (24b) can be represented as follows:

(25) $\forall w'[[\forall x.\text{Leader}(x,w') \land \text{Violent}(x,w') \rightarrow S(x,w')] \rightarrow [\forall x.\text{Leader}(x,w') \land \text{Violent}(x,w') \rightarrow \text{Dangerous}(x,w')]]$

where S is an IVO associated with violent leaders that reasonably causes danger.

However, there is something with this interpretation that does not seem correct. What is it that makes violent leaders dangerous other than them 'being violent'? It is exactly the addition of the adjective 'violent' that made the false (24a) into a true IS generic. Thus, one must interpret (24b) as a IS generic that offers its IVO explicitly in the generic sentence. So

(25) must be interpreted as saying leader are dangerous in virtue of being violent. Then we have this:

(26) $\forall w'[[\forall x.\ Leader(x,w') \wedge Violent(x,w') \rightarrow Violent(x,w')] \rightarrow [\forall x.\ Leader(x,w') \wedge Violent(x,w') \rightarrow Dangerous(x,w')]]$

But it is a non-informative analysis to say that if someone is a leader and violent, then she is violent. Thus, the IVO property is doing nothing here. The accessibility relation is already restricted with the subject's qualification, and (24b) should be taken to say 'if violent, leaders are dangerous', which is to say that leaders are dangerous in virtue of being violent. Hence, we end up with this:

(27) $\forall w'[[\forall x.\ Leader(x,w') \rightarrow Violent(x,w')] \rightarrow [\forall x.\ Leader(x,w') \rightarrow Dangerous(x,w')]]$

We can see that (27) is the interpretation that we would give of (24a). Therefore, Greenberg's interpretation does not provide a correct interpretation for (24b).

The other problem that Greenberg's account has is that it gives a wrong interpretation many definitional generics. Consider these examples:

(28) a. An electron has a negative electric charge of 1.6×10^{-19} coulombs.

b. A fermion has a half odd integer spin.

c. A triangle has three sides.

An electron, a fermion, and a triangle do not have the properties predicated to them in virtue of any other associated property that reasonable causes the predicated property. An electron has the predicated property in virtue of being an electron, as do fermions and triangles. At first, it may not seem a grave problem. One may say that these definitional statements are fundamentally definitional and conceptually necessary, hence saying that the statement is true in virtue of the individuals picked by the subject noun phrase being of the kind they are. For example, the interpretation of (28a) would be as follows:

(29) $\forall w'[[\forall x.\ Electron(x,w') \rightarrow Electron(x,w')] \rightarrow [\forall x.\forall y.\ Electron(x,w') \wedge UNCharge(y,w') \rightarrow Has(x,y,w')]]$

which is equal to:

$\boldsymbol{\forall w'[\forall x.\forall y.\ [Electron(x,w') \wedge UNCharge(y,w') \rightarrow Has(x,y,w')]}$

The statement in (29) is just saying that unconditionally necessarily everything that is an electron has the unit negative charge. This is true. The problem, however, is that Greenberg had two constraints on the choice of the IVO property, and these constraints will not allow us to choose the IVO we picked in (30).

Firstly, saying the property 'being an electron' is the property associated with electrons is an uninformative and trivial. According to the interpretation I gave earlier, it amounts to saying that a normal electron is one that is an electron, which is no lead on what is a normal electron at all. Secondly, the more serious problem is that IVO is supposed to be *a reasonable causer* of the predicated property. Picking an electron's being an electron as the IVO here requires us to accept self-causation which is unacceptable. To cause something requires priority to the effect. But something cannot exist prior to itself. So 'being an electron' cannot cause 'having a certain charge' because to be an electron is to be a particle of a certain charge. It is not the case that something is an electron without charge and then it causes the charge to come to existence. Electron is just a name given to something that has a certain charge and spin. Therefore, the relation between 'being an electron' and 'having a certain charge' is linguistic and not causal, just as the relation between 'being a bachelor' and 'being an unmarried man' is not causal, but linguistic.

These two problems are enough reason for us to look for a more efficient alternative interpretation for definitional generics. In the next sub-section I will argue for an alternative approach based on the work of Krifka.

3.2 Krifka and Definitional Generics

Krifka's (2012) proposal is based on the assumption that the definitional generics are analytic statements that "restrict the language used to describe the world", while descriptive generics make "generalizations about the patterns that appear in the world." Consider the general modal schema (30).

(30) $\forall w'[[w'Rw] \rightarrow \forall x[P(x,w') \rightarrow Q(x,w')]]$

In (30), we only have possible worlds with respect to which we can interpret expressions. However, since we want to be able to modify and restrict our use of language, Krifka suggests that we need to distinguish between what the worlds are like and how the expressions can be interpreted. In order to do this, we can introduce two indexes to our extension assignment, one for possible worlds (w) and one for interpretations (i): $[\![\alpha]\!]^{w,i}$ then represents the extension of the expression α with respect to world w and interpretation i. The index 'w' corresponds to the factual state of the worlds and the index 'i' corresponds to interpretational differences. So two expressions are factually different if $[\![\alpha]\!]^{w,i} \neq [\![\alpha]\!]^{w',i}$ for the two pairs $<i,w>$ and $<i,w'>$, and two expressions are interpretationally different if $[\![\alpha]\!]^{w,i} \neq [\![\alpha]\!]^{w,i'}$ for two pairs $<i,w>$ and $<i',w>$.

Since we divided the expressions' index into two parts, we should also divide the common ground, which contains our already believed and accepted presuppositions and common knowledge with respect to a context, into two parts as well: a set of admissible interpretations 'I' and a set of possible worlds 'W', so the common ground 'C' is a pair $<I,W>$ of the set of interpretations and possible worlds. Now, we have the resources to introduce Krifka's proposed schema for the semantics of definitional and descriptive expressions as follows:

(31) Definitional: $C + DEF([\![\Phi]\!]) = <\{i \in I | \forall w \in W\ [\![\Phi]\!]^{i,w}\}, W>$

Descriptive: $C + DES([\![\Phi]\!]) = <I, \{w \in W | \exists i \in I\ [\![\Phi]\!]^{i,w}\}>$

According to (31), if a proposition is accepted definitionally at the common ground, then there will be no change in the set of possible worlds, but the admissible interpretations will be limited to those for which the proposition is true in all worlds. If a proposition is accepted descriptively at the common ground, then the interpretations in the common ground would stay fixed, but the set of worlds will be limited to only those for which there is at least one interpretation for which the proposition is true.

To illustrate how this schema works, consider the following generic sentence:

(32) A dog has four legs.

Assume that the set of interpretations in our common ground is $I_c=\{i_1,i_2,i_3\}$, and the set of possible worlds is $W_c=\{w_1,w_2,w_3\}$. Only in w_1 dogs have four legs and in the other two worlds they have three legs. On the other hand, in i_1 and i_2, dogs are considered such that they must be four legged animals, while in i_3 they must be three legged. Now, if we accept (32) in our common ground definitionally or descriptively, the common ground will be updated as follows:

(33) Definitional: $<I_c,W_c> + DEF([\![\text{a dog has four legs}]\!] = <\{ i_1,i_2\},\{w_1,w_2,w_3\}>$

Descriptive: $<I_c,W_c> + DES([\![\text{a dog has four legs}]\!] = <\{ i_1,i_2,i_3\},\{w_1\}>$

Notice how the definitional update keeps the worlds in which dogs are four-legged and three-legged untouched and changes the interpretation of 'dog' so that it can only be applied to the four-legged ones. What happens here can be made more clear if we consider that we were in w_2. There are no four-legged dogs around in our world, but since we accepted (32) definitionally in w_2, the three-legged animals around us are not to be considered normal dogs anymore. Three-legged dogs will not be normal dogs in w_2 because the definition says for something to be a dog, it needs to have four legs. The generic (32) is partial definition of what a dog is, and if we accept a complete, or a sufficiently elaborate definitional generic about dogs, something along the line of "a dog has four legs, furry body, a certain genetic makeup, etc.", such that what has been called a dog in our world before accepting the definitional generic lacks those properties, then not only our world previously called dogs are no more normal dogs, but they will not be dogs at all. The issue of partial and complete definitions, however, depends on the metaphysical questions regarding the essential properties of kinds, which goes beyond the scope of this thesis. It suffices to say that on the present interpretations, definitional generics can change the way we parse the world.

Now, that we have the general schema for the definitional/descriptive distinction, we must see what is truth conditions for Φ. The modal account introduced in (30) is perfectly fine for the definitional Φ.

(30) $\forall w'[[w'Rw] \rightarrow \forall x[P(x,w') \rightarrow Q(x,w')]]$

This is what we expect of an analytic truth: given the interpretations under which Ps are Qs, with respect to every accessible possible world anything that is a P is also a Q.

However, things are not as easy with the descriptive Φ. Consider the following generic:

(34) Mustangs go 200 km per hour.

Given the simple modal reading, this sentence expresses that in all possible worlds where a Mustang works as it is supposed to, it runs with the speed of 200 km per hour. However, the most natural reading of (34) is that Mustangs are such that they have the capacity of going 200 km.h not that they run at that speed all the time. The only way that (30) can capture this latter reading is to modify the accessibility relation such that it restricts the possible worlds to only those in which a mustang is designed to run 200 km.h and it is running at its full capacity. However, firstly, even if there are no worlds where a Mustang runs at its full capacity, it is still true that it has the capacity in virtue of its design. Secondly, and more importantly, allowing this much liberty in determining the accessibility relation will lead to overgeneration of true generics. For example, we can use the same strategy to make a clearly false generic such as ‘rubber breaks’ true, if we determine the accessibility relation so that it restricts the worlds to only those in which rubber is critically cold and about to be broken. Therefore, (30) is not a good interpretation of generics like (34).

The other type of generics that the simple modal interpretation has difficulty accounting for are absolute minority generics. Consider the following example.

(35) Mosquitoes carry West Nile virus.

According to the simple modal interpretation, (35) says that in all suitably accessible world, every normal mosquito carries West Nile virus. However, while (35) is considered as true, only very few mosquitos are West Nile vectors. It is very difficult to see how can we determine an accessibility relation over worlds where normal mosquitos carry the virus, while actually the absolute majority of them do not. I believe these two examples are enough to show that we need an alternative interpretation to (30) that can provide a better account of various descriptive generics. I will argue that an alternative can be sought using the in-virtue-of theory proposed by Greenberg.

3.3 IVO Theory and Descriptive Generics

In 3-1, I argued that the IVO theory is not a successful account of definitional generics. However, I want to argue that the conditions of normality that the IVO theory provides is a good tool to make sense of descriptive generics. Descriptive generics characterize normal members of a kind predicating a generic property to them. They restrict the domain worlds to only those in which normal members of the kind have the property in question. This is the way we treat exceptions to descriptive generics. So, for example, albino ravens and amputated dogs are abnormal members of the kinds raven and dog, where normal ravens are black and normal dogs have four legs. Thus, if IVO is providing conditions for normality, it can be used to account for descriptive generics.

The IVO theory is a powerful account of what constitutes normality of the subjects of characterizing predication. Firstly, it takes into account stereotypes, conventions, and so on that play a role in defining what one takes in a context as normal through the association constraint. For example, an account that relies only on natural facts to establish normality would have difficulty accounting for normality of Scottish children in the example below:

(36) Scottish children start school at the age of four or five.

It is difficult to see what facts related to the nature of a Scottish child who is in school at the age four can make them a normal Scottish child and the one who starts school at 6 abnormal. However, if we take into account the norms about school age that Scottish society associates with children, then it would become clear in what respect a six years old Scottish child who has just began school is abnormal.

Secondly, Greenberg's account of normality with respect to IVO properties has the advantage of being able to deal with kinds that are differently normal in different contexts.

(37) a. Dobermans have floppy ears.

b. Dobermans have pointy ears.

The example is taken from Sterken (2015). Showing the difficulty of making sense of these generics, she argues for indexicality of generics. However, the IVO theory can account for the context-sensitive generics without going too far to treat them as indexical. Dobermans are genetically such that they possess floppy ears. However, most Dobermans one sees are those that dog breeders have bred, and it is a practice in dog breeding to cut the ears of Dobermans to a pointy shape. Therefore, both (37a) and (37b) state true generics when uttered in the right context, that is, an animal biology discussion and in a dog breeding discussion respectively. The only way that Drewery can deal with the truth of these sentences is to claim that the Dobermans of (37b) are a different kind of Dobermans compared to the natural Dobermans of (37a), and thus have different normality conditions. However, this strategy may strike us as strange. Dobermans are Dobermans, and properties we associate with them in different contexts will not variate the kind itself. It may be insisted that dog breeders' Dobermans are a different kind since they have been engineered to be presented as custom bred dogs. But the following example would show that a change in convention or governing principle will not change a kind:

(38) a. A massive object falls when released

b. A massive object floats when released.

The sentence (38a) is true in all normal situations on Earth or anywhere with effective centripetal gravitational force, hence the normality of falling objects. The sentence (38b) is true in all normal situations in moon or wherever there is no strong gravitational force on any direction, hence the normality of floating objects. However, we do not want to say that the massive object of (38b) is different from (38a).

The IVO property would help us deal with this problem neatly. The difference in normality of Dobermans in (37) can be accounted for by saying this: floppy eared Dobermans are normal in virtue of their genetic makeup associated with floppy ears in an animal biology context, which reasonably causes Dobermans to have floppy ears. Pointy eared Dobermans are normal in virtue of the dog breeding practice associated with pointy ears in dog breeding contexts, which reasonably causes Dobermans to have pointy ears. The same can be said about (38) and gravitational force IVO.

The IVO theory, which was meant to capture the difference between definitional IS generics and descriptive BP generics, can easily be extended to other characterizing generics and efficiently account for descriptive normality. Greenberg (2007) suggests this extension and claims that while both definitional and descriptive generics have the same interpretation, the difference stems from the fact that while the IVO in definitional generics is specified, it is unspecified or unknown in descriptive generics. While it is true that some descriptive generics have unspecified or unknown IVO properties, it is not necessarily so. For an example of a generic with an ambiguous IVO property, consider a case such as (39) where a very odd kind of property is predicated in the generic sentence:

(39) Norwegian students with names ending with ‘s’ wear thick green socks.

On a generic reading, it is indeed very difficult to imagine what IVO property is associated with ‘Norwegian students with names ending with ‘s’’ that reasonably causes them to have the property of ‘wearing thick green socks’. It is for this reason that while accepting or confirming the truth of such generics is not impossible, one would normally have difficulty to do so. However, this is not the case for all descriptive generics. Consider the following examples:

(40) a. K-Pop bands are popular.

b. Mustangs go 200 km per hour.

c. Sharks attack bathers.

The sentences in (40) are clearly descriptive. Read definitionally, generics in (40) will be infelicitous. However, they seem much more agreeable and confirmable than (40). As one can easily come up with the 'genetic makeup' IVO for dogs' having four legs', one can come up with 'strong publicity; party enlivening vibes; cultural indoctrination' IVO for (40a).

The same goes for (40b), which as we have seen before is a dispositional descriptive generic. We saw that the simple modal interpretation had difficulty making sense of (40b). However, The IVO theory can provide a correct interpretation of such generics. According to the IVO theory, (40b) predicates to 'Mustangs' that there are properties such as a specific engine design and aerodynamics associated to them that would reasonably, according to laws of mechanics, cause Mustangs to run at the speed of 200 kh.h when the property is triggered. The same goes for all dispositional descriptive generics. An IVO can effectively explain why one is ready to accept the truth of such generics: for example, 'salt is soluble in water' is true because there is a property, namely the polar molecular structure associated with salt that causes it to be dissolved when put in water.

The case of (40c) is more curious. These kind of generics, which Leslie (2008) calls troublesome generics, are difficult to make sense of, as we have seen that the simple modal interpretation had difficulty doing so. Such generics are true despite the fact that the absolute majority of the members of the kind which is the subject of the generic predication are exceptions to the generic statement. I suggest that the best way to understand these generics is to consider them as dispositional descriptive generics. "Sharks attack bathers" is not true because all normal sharks, however this normality is defined, attack bathers. The generic is true because normal sharks have certain properties that if triggered cause them to attack bathers. Thus, (40c) says that there are properties such as 'being carnivore predators', 'being hungry', 'being sensitive to the scent of blood', etc. which are associated with sharks and they cause sharks to attack bathers when they triggered.

We can see that the IVO theory is, on the one hand, a powerful tool for determining normality and what counts as exception to descriptive generics, and on the other hand, can account for generics of which the simple modal interpretation cannot give a sufficient analysis. Therefore, I suggest that it is reasonable to interpret the descriptive Φ in our proposed semantics for generics with the IVO interpretation. Doing so, we will finally arrive at the following as the semantics for generics:

(41) GEN(x)[P(x)][Q(x)]

Definitional: $\langle I,W\rangle + DEF([\![\Phi]\!]) = \langle\{i\in I|\forall w\in W\ [\![\Phi]\!]^{i,w}\},W\rangle$

Descriptive: $\langle I,W\rangle + DES([\![\Phi]\!]) = \langle I,\{w\in W|\exists i\in I\ [\![\Phi]\!]^{i,w}\}\rangle$

where the

definitional Φ is $\forall w.\forall x.[P(x,w) \rightarrow Q(x,w)]$, and

descriptive Φ is $\forall w.[[\forall x.[P(x,w) \rightarrow S(x,w) \wedge$ (S is associated with P) $\wedge$ (S is a reasonable causer of Q)]] $\rightarrow [\forall x.[P(x,w) \rightarrow Q(x,w)]]]$
where S is an IVO property.

So far, we saw that the distinction between definitional and descriptive generics can be made sense of by an analysis that treats them in a disjoint manner. I proposed that a synthesis of Krifka's theory of definitional generics and the IVO theory provides us with a powerful tool to account for various types of generic generalizations. In the last part of this section, I will show that that the schema provided in (41) provides a correct analysis of law statements, given what I argued for in section 1.

3.4 The semantics of Law Statements

In section 1, I proposed a general distinction between law statements and divided them into definitional law statements and descriptive ones. Then, in the following section, I argued that the standard schema lacks resources both to account for the differences between law statements and to provide satisfactory semantics for them. In what follows, I will show how the machinery I developed in subsection 3-2 will provide a powerful and clear interpretation of law statements.

The semantics introduced for generics relies on an element we called the common ground. So let us see what the common ground for law statements is. Law statements are perhaps the most important part of sciences. On the one hand, the apex of scientific discovery is the discovery of a pattern that generalizes myriad instantiations of a particular way of unfolding of things in the world, and on the other hand, laws are the basis of most, if not all, scientific explanations, predictions, and inferences. Law statements are the tenets of our understanding of the world. So it may be reasonable to say that the common ground in which law statements are expressed consists of all propositions that constitute sciences. But this is obviously too broad. Surely the common ground for the laws of physics shares very little with the common ground for laws of biology. Even if we endorse a very strict reductivism that suggests everything is ultimately reducible to fundamental principles of physics, it is useless to say that we can understand and confirm the working of a biological law on the basis of our knowledge of physics, unless the biological law is stated in the language of physics.

The next natural thing is to say the common ground for laws is the science to which those laws belong. So, for example, the common ground for physical laws is physics. This suggestion may look good, yet it is too broad as well. A second year physics student and a mechanical engineer can have a very good command and understanding of Newtonian mechanics and use Newton's laws to explain or predict phenomena having no idea about quantum mechanics and relativity theory. So laws of Newtonian mechanics are proposed, understood, and confirmed in a common ground that consists of propositions about point masses, inertial reference frames, absolute time and space, instantly propagating omnidirectional forces and so on. This means that the common ground for Newton laws is the theory of Newtonian mechanics itself.

So it can be said that the common ground for law statements is the theory with respect to which they have been generated. I argued that what makes a theory is the kinematical constraints that define the permissible (explainable) systems of that theory. A Newtonian mechanical theory is the collection of kinematical constraints that define its systems. So what the definitional laws defining systems do is to update the common ground with interpretations that only allow certain systems to be the subjects of the scientific theory in the common ground. So for example the Gauss law of magnetism update the common ground with an interpretation of an electromagnetic system that would exclude magnetic monopoles. So a classical Maxwellian theory of electromagnetism is true only in worlds where this interpretation holds.

With the systems of the theory defined, the next step is to make sense of the postulates and their relations. Again, I argued that law statements that govern these postulates are also definitional. For example, Newtonian force and mass cannot be made sense of without the Newton's second law and universal gravitation. So while the definitional laws defining systems make a common ground against which the definitional laws defining postulates can be made sense of: the latter update the common ground of their respective theory with the interpretations of the entities and forces that appear in the systems of that theory. The definitional laws, thus, define a theory with respect to which scientists set to study the world.

As an example, consider $<I_m,W_m>$ to be the basic common ground of the mechanical possibilities, and Γ the conjunction of all definitional laws of Newtonian mechanics. According to the interpretation (41), what these laws express can be captured as follows:

(42) $<I_m,W_m> + DEF(⟦\Gamma⟧) = <I_{NM},W_m>$

where the index 'NM' is short for Newtonian Mechanics

What (42) says is that if we accept the laws of Newtonian mechanics, in all possible worlds, irrespective of whether those worlds are Newtonian, a Newtonian system is one where reference frames are inertial, velocity is displacement is time, net forces equal mass times acceleration, gravity is an evenly propagating omnidirectional force that diminishes in intensity by the inverse square of distance from the source, and so on.

If we accept these law statements and come across a real world system that does not fit this picture, then two things can happen: one is to consider the system as abnormal due to the presence of some interference and try to figure out what the interference is. The other happens when in order to account for the abnormality one needs to come up with a new postulate or redefinition that would contradict some of the definitions in the common ground. Then we know that we have reached the limits of the theory and should deem the system, for example, as non-Newtonian. The questions of fit, confirmation, and falsification go well beyond the scope of this paper, so I will not discuss these further. It only suffices to say that this is how strongly definitional law statements resist non-conformer instances: so far as no new definition that would contradict what is already accepted in the common ground can be conceived of, everything that does not fit the definition is merely an apparent exception. And this is how actual scientists treat scientific theories and law statements. In the face of the discrepancies between the calculated value of muons magnetic moment and the value obtained experimentally, the scientists' first choice of strategy is to account for this anomaly is terms of interferences or calculation error, rather change the definitions of the standard model of particle physics.

So far the semantics we proposed for law statements is working as we expected. Let us see how it fares with the descriptive laws. The first type of descriptive laws that I introduced in section 1 are those that describe instantiations of system. This means that these laws hold fixed the definitions of a system and describe patterns of behavior of particular models within that system. Remember the law of the simple harmonic as an example:

(43) $F = -kx$

This law statement is not a definition of force, spring stiffness, or displacement. It accepts the definitions of these elements as fixed by the Newtonian mechanics' theory in the common ground, and describes the behavior of massive bodies (concealed in the definition of F) that oscillate around a point of equilibrium. So (43) is true only where there is an interpretation force that allows an understanding of it in terms of mass and acceleration. (43) is also true in virtue of the internal structure of the elastic bound that limits its displacement and is represented by the empirically obtained spring constant ‘k’. Both of these are captured well in the semantics I proposed for generics.

(44) $<I_{NM},W_m> + DES([\![\Phi]\!]) = <I_{NM}, \{w\in W|\exists i\in I\ [\![\Phi]\!]^{i,w}\}>$

where Φ is $\forall w.[[\forall x.[P(x,w) \rightarrow S(x,w) \wedge$ (S is associated with P) $\wedge$ (S is a reasonable causer of Q)]] $\rightarrow [\forall x.[P(x,w) \rightarrow Q(x,w)]]]$
where S is an IVO property.

where $\exists i\in I$ ensures that the law statement is assigned extension given the accepted interpretation of force (Newton’s second law) and S is the limit set by the internal structure of the spring associated to a simple harmonic that would reasonable cause the restoring force to be proportional to ‘–kx’. We know that this law would break when the elasticity of the spring (or the similar equivalent) is tampered with. In these cases, then, it is the IVO property and its constraints that help us rule out the anomaly as merely exceptions to the law of simple harmonic and not falsifications of it, since the normal spring is one that has the internal structure determined by the IVO property, and this structure causes, according to the definitional laws of the system, the spring to behave as predicted. If this has not achieved, it is either because the spring has lost its IVO property or there is an interference blocking the reasonable causation to be triggered.

The descriptive laws that describe principled dispositions also fit my proposed semantics. Unlike the laws we saw so far, which are usually expressed as mathematical formulas, these descriptive laws do not have mathematical formulation and are always expressed in natural language. Consider again the following examples:

(45) a) Water boils at 100°C.

b) Metals conduct electricity.

Law statements in (45) are dispositional descriptive generics. (45a) says that a sample of water in standard situation (at sea level) will be brought to boiling at 100°C when heated, and (45b) says a piece of metal will conduct electricity if electric current is applied to it. Again both water and metals are disposed to the properties predicated to them in virtue of a more fundamental property that is associated to them and reasonably causes the predicated property, namely, water's molecular energy and metals' sea of loose electrons due to their atomic structure respectively.

It may be said that it seems possible to read, for example, (45b) as a definitional, why consider it as descriptive. It is true. However, the question of which reading is salient should be settled by the information available in the common ground and the demands of context. Firstly, in the context of physics, matter is defined by its fundamental structure and not the properties it possesses in virtue of having that structure. Secondly, I mentioned that the definitional laws are associated with stronger modality (they are conceptually or, as Hirèche et al (2020) claim, metaphysically necessary), but a generalization like (45b) is only nomologically necessary. (45b) can be a definitional law in a much more primitive theory of the world, where phenomenal behaviour of metals is all we have to define what metal is. However, in modern physical theories, it can only be a descriptive law, since metalhood is defined by more fundamental laws governing the arrangement and interactions of fundamental particles and not the phenomenal behaviour of those arrangements.

In this thesis, I confined myself to laws of physics, with the hope that since physics is considered the most fundamental and exact of all sciences, if I am successful with making a case for my proposal, it can be easily extended to special science laws as well. Many have argued in favor of the laws of special sciences as generics of some sort (Drewery 1998; Nickel 2010; Claveau & Girard 2019). I will not be able to give a full treatment of them, as I provided here for laws of physics, both due to lack of space and because I am not familiar enough with the full span of these laws. However, I believe it is reasonable to believe that since special science are also scientific theories that are in the business finding nomic regularities, the logical form and semantics I proposed here for laws of physics, can be applied to them as well.

Conclusion

In this thesis, I attempted to challenge the idea that statements of the laws of nature are semantically homogenous and suggested a semantics for them arguing that the best way to account for what law statements mean is to consider them as generic generalizations.

There are many statements that philosophers and scientists call statements of laws of nature. Law statements are true lawlike generalizations, where to be lawlike is to be universal, unrestricted, and modally robust. It is often assumed that these laws can be given a unified analysis in the form a universal generalization which is either modalized or receives its modal robustness from the meanings of the terms involved. However, I argued that giving such unified analysis is not possible. In order to show that I argued, firstly, that law statements should be divided in two groups: definitional laws and descriptive laws. Definitional and descriptive laws express fundamentally different things. Definitional law statements set the theories with which we talk about the world by defining the systems that are allowed to be subject of experimentations and the postulates and terms with which those systems are described. Descriptive laws, on the other hand, describe the behaviour and relations of the instantiations of the systems defined by our scientific theories and the nomic dispositions of the natural kinds. These two types of laws cannot be given a unified analysis, since the former are analytic, conceptually necessary statements, while the latter are empirical nomologically necessary ones.

Secondly, I argued that the first-order logic universal quantification, which is often proposed as basis for analysis of law statements, is insufficient for this task. Firstly, it is incapable of capturing the distinction between definitional and descriptive law statements. Secondly, it is not sufficient to express law statements, since first-order logic universal quantification cannot distinguish between accidental and lawlike generalizations. Thirdly, it cannot make sense of the interferences that may affect the predictions of law statements.

I proposed that generic generalizations are a good alternative to first-order logic universal generalization for expressing lawlike generalizations. Generics are inherently lawlike, capable of accounting for interferences by determining what a normal generic subject is. Generics are particularly a good alternative analysis of law statements because they are, like statements, divided in two types of definitional and descriptive generics, which have disjoint semantics that can be mapped into the semantic distinction between definitional and descriptive laws.

Having argued for the plausibility of an analysis of law statements as generic generalizations, I attempted to provide semantics for generics on the basis of the works done by Krifka and Greenberg. I argued that while Krifka convincingly contends that definitional generics should be treated as analytic statements that keep the possible worlds fixed and determine the interpretations under which a statement is true, his account has difficulties accounting for a number of generics including absolute minority and dispositional generics. In order compensate for this shortcoming, I turned to Greenberg's theory of in-virtue-of (IVO) generics. I argued that while the IVO theory has problems accounting for the definitional generics, it provides us with a powerful tool to determine normality in descriptive generics and help us account for problematic descriptive generics that Krifka's theory was unable to deal with. Therefore, I proposed a synthesis of Krifka's and Greenberg's theories and showed that the resulting theory can successfully provide us with a theory of what law statements mean.

Abstract

Many philosophers and scientists believe that the statements of laws of nature can be given a unified analysis. Law statements are thought to be true lawlike generalizations, where to be a lawlike generalization is to be a universal, spatiotemporally unrestricted, and modally robust generalization. It is the legacy of logical empiricists that such generalization can be analyzed as a universal generalization of the form $\forall x.(Fx \rightarrow Gx)$. Since the logical empiricists, this analysis has been criticized and various alternatives have been proposed. One proposed analysis is that lawlike generalizations, and hence law statements, should be analyzed as generic generalizations (e.g. Drewery 1998, 2005; Nickel 2010; Claveau & Girard 2019). These accounts, however, endorse the assumption that law statements can be given a unified analysis and attempt to analyze law statements as generic generalizations in unified manner. In this thesis, while endorsing the suggestion that law statements are generic generalizations, I will challenge this assumption arguing that law statements should be divided into two distinct groups, the definitional laws and descriptive laws, which require distinct analyses. I will, then, provide an analysis of law statements on the basis of the works of Manfred Krifka and Yael Greenberg on definitional and descriptive generic generalizations.

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