Abstracts

Tomasz Bigaj
On the topological approach to the metaphysical problem of indistinguishable quantum particles

The standard quantum theory of many particles imposes an important restriction on the available states of particles of the same type. This restriction takes on the form of the symmetrization postulate, according to which the state of a system of “indistinguishable” particles has to be either symmetric (for bosons) or antisymmetric (fermions) with respect to the permutation of individual particles. The symmetrization postulate is applied to reduce the number of accessible states that can be identified in a full tensor product of N individual (labeled) Hilbert spaces. However, there are some alternative ways of representing mathematically states of indistinguishable particles. In the topological approach, the configuration space is obtained by identifying all the elements of the full tensor product of individual spaces that differ only with respect to the permutation of the elements (this procedure is known as “quotienting out”). The resulting configuration space appears to have new interesting topological properties due to the existence of singularities at points where two or more particles possess the same state. In particular, it can be shown (Leinaas & Myrheim 1977) that the difference in global topology between configuration spaces for distinguishable and indistinguishable particles naturally leads to the symmetry constraints on the states of particles of the same type. In this article the topological approach will be compared to yet another method of representing the states of indistinguishable particles recently suggested by Ladyman et al. (2013). In this latest proposal the states of N particles of the same type are constructed with the help of the symmetric or antisymmetric “wedge” product rather than the full tensor product. The wedge product of two vectors is defined as the equivalence class that contains all and only vectors of the ordinary tensor product for which the operation of symmetrization (antisymmetrization) gives the same result as when applied to the direct product of the initial vectors. Both the topological approach and the wedge formalism will be analyzed with respect to their ability to shed new light on the metaphysical problem of indistinguishable particles, which is the question whether quantum particles of the same type can be discerned by any meaningful physical properties or relations, and whether they can thus achieve the status of individual objects equipped with their own unique identities. Another question addressed in the paper will be the problem of the redundancy of some parts of the mathematical formalism used in the description of physical reality (the problem of “surplus structure” in Michael Redhead’s terminology). It turns out that both the topological approach and the wedge formalism present us with their own unique ways of eliminating such surplus structures in the case of the quantum theory of many particles.
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Samuel Fletcher
Topological Structure on Scientific Theories

I review and amplify on some of the many uses of representing a scientific theory in a particular context not just as a collection of models, but as a topological space. Topological structure on a set encodes among that set’s elements a notion of similarity, which proves fruitful in the analysis of a variety of issues central to the philosophy of science. These include intertheoretic reduction, idealization and approximation, emergence, the epistemic connection between modeling and knowledge, and modality in science. The morals are twofold: first, the further adoption of topological (and related) methods has the potential to aid decisive progress in philosophy of science; and second, the selection and justification of a topology is not a matter of technical convenience, but rather often involves great conceptual and philosophical subtlety.

Benjamin Feintzeig
Topological Considerations in the Construction of Quantum Theories
It is well known that the process of quantization, constructing a quantum theory out of a classical theory, is not always a well-defined procedure in physics. There are many inequivalent methods that lead to different choices for what to use as our quantum theory. In this paper, I show that paying close attention to topological information in classical physics, which encodes manifestly physically significant notions of approximation, can help us choose between competing quantization procedures. I show that by requiring the topological information about approximation to line up between classical and quantum physics, we constrain and inform the quantum theories that we end up with.

Rafał Gruszczyński
Half-planes, ovals and spheres. Point-free systems of affine and Euclidean geometry
The task of point-free geometry is to construct systems of geometry in which the notion of *point* is not assumed as basic. I will briefly describe three such systems, each of which will be based on the individual notion of *region* and the relational notion of *being part of*. Additionaly, every system will have its own specific notion:

- of *half-plane*, in case of the system of Aleksander Śniatycki from [3]
- of *oval*, in case of the system of Giangiancomo Gerla and Rafał Gruszczynski from [2]
- of *sphere*, in case of the system of Alfred Tarski from [4].

I will analyze the axioms of the aforementioned theories and display pre-theoretical (spatial) intuitions behind them. Explanation how elementary geometrical notions of *point*, *betweenness* and *equidistance* are defined within the appropriate systems will also be included.

[1] G. Gerla, R. Gruszczynski Point-free geometry, ovals and half-planes, submitted

[2] R. Gruszczynski, A. Pietruszczak, Full development of geometry of solids, Bulletin of Symbolic Logic, 14(4), 481-540, 2008.

[3] A. Śniatycki, An axiomatics of non-desarguean geometry based on the half-plane as the primitive notion, Dissertationes Mathematicae, no. LIX, PWN, Warszawa, 1968.

.[4] A. Tarski Les fondements de la géometrié de corps, Księga Pamiatkowa Pierwszego Polskiego Zjazdu Matematycznego, suplement to Annales de la Societé Polonaise de Mathématique, Kraków, 1929, pp. 29-33.

Laurenz Hudetz
Representing points as classes of mereotopologically structured basic entities
It has been suggested by a number of authors (most prominently Whitehead and Russell) that spacetime points should be identified with classes of mereotopologically structured basic entities. These suggestions are mainly motivated by either of the two following views: (a) the empiricist or relationist view that statements about spacetime points should be reduced to statements describing relations between epistemologically or metaphysically preferable entities such as processes and events; (b) the view that talk about spacetime points should be meaningful even in the case that the mereological structure of spacetime regions is atomless (given substantivalism about spacetime regions).
In order to evaluate the feasibility of such suggestions, two main questions need to be answered: (Q1) Under which conditions is a point representation method-i.e. a method of identifying points with classes of mereotopologically structured basic entities—generally adequate? (Q2) Are there any adequate point representation methods in that sense? My talk addresses exactly these two questions. If we want to treat question Q1 in a systematic and rigorous way, we first of all need a unified formal

framework for analysing and evaluating different point representation methods. I propose a unified framework, in which I explicate a general notion of point representations and the notion of general adequacy of point representations. Thereby, we obtain an answer to Q1 and transform the informal question Q2 into a precise, mathematical question.

I then examine important point representation methods within the proposed framework and present the main results I have achieved so far. It can be proven in a rigorous manner that the method which identifies points with limited maximal round filters-as suggested by Roeper (1997) and Mormann (2010)-is generally adequate. So question Q2 has a positive answer. Other salient methods such as the method employing ultrafilters as points (along the lines of Stone’s representation theorem) and the method using completely prime filters (as usual in point-free topology) can be proven to be not generally adequate and we can pinpoint the reason for their inadequacy.

Janusz Kaczmarek

Mathematical tools in ontology of ideas, concepts and individuals

The topic of our conference is: topological philosophy. I understand it as application and utilizing topology in philosophy and its problems – but not conversely. Due to the fact that I deal with ontology primarily I will understand the topic as a question: to what extent can topology contribute ontology or if topological concepts and tools allow to interpret concepts and problem of ontology.In my monograph *Individuals. Ideas. Concepts ...* I proposed some collection of terms and notions that are important to ontological investigations. I pointed out the following levels and relevant terms:a) the level of individuals – (terms) individual, property, essential and attributive property, positive and negative property, complete object, extension of idea, b) the level of ideas – general object, species, genera, hierarchy of general objects, species difference, property of idea and property given in a content stratum of idea, c) the level of concepts – concept, the structure of concepts, content of concept, positive and negative content, extension of concept.Definitions of terms and notions in question and some theorems I gave in set-theoretical language. So, now the problem is: is it possible to collect some set of ontological notions defined in topological language?At the conference I will propose two small and modest ideas: 1) every individual (object) o is understood as a pair (X, TX), where X is interpreted as non-empty set of properties and TX is topology on X; this attempt will allow us to compare the individual with a concept of object given by Twardowski in his *Zur Lehre vom Inhalt und Gegenstand der Vorstellungen*; open sets of TX we can interpret as first order ingredients of an individual and elements of open sets as second order ingredients; both first and second order ingredients are properties of an individual, 2) let X be a 4-dimensional connected space, <x, y, z, t> X, <x, y, z> are space coordinates and t is time coordinate; every curve from <x, y, z, t> to <x’, y’, z’, t’> we interpret as a real object (individual); with each point <x, y, z, t> of an object o we will join a set of properties P; next we will define essential properties, obtained and lost properties, and using different structures of time we will give semantically described temporal logic.

Marek Kuś

What topology can offer physics. Topological constraints and predictions in classical and quantum worlds

Complaining that „[v]on der *Geometria Situs*… wissen und haben wir nach anderthalbhundert Jahren noch nicht viel mehr wie nichts“, Carl Friedrich Gauss, as a clear example what can be done to change this unfortunate state of the matter, gave in 1833 a derivation of the so called *linking number formula* for two intertwined curves. For Gauss his result provided also a link between *geometria* (or, occasionally, *analysis*) *situs* (topology) and *geometria magnitudinis* (analytical geometry). Nearly half a century later James Clerk Maxwell realized its connections with electromagnetic theory explicitly referring to its topological origins. In this way topology entered physics.

Using the above and other examples (Dirac and t'Hooft-Polyakov monopoles, Aharonov-Bohm effect, dislocations in cristals) I will try to show the role played by topology in physical theories. I will argue that relatively 'innocent" concept of continuity on which topology is based, imposes concrete restrictions on properties of existing and non-existing (Dirac monopole) physical quantities, providing, on the other hand, new tools (topological quantum computing).

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Andrzej Leder
IN WHAT KIND OF SPACE DO HUSSERL"S LECTURES ON THE PHENOMENOLOGY OF THE CONSCIOUSNESS OF INTERNAL TIME TAKE PLACE?

Husserl's sentence: "The manner in which variation of curvature makes the various sorts of space-like manifolds pass into one another, gives the philosopher who has familiarized himself with the elements of the Riemannian-Helmholtzian theory a certain picture of the manner of the mutual legal connection among pure forms of theory of determinately distinct types." – introduces a certain strong philosophical assumption. Namely, it assumes that the "pure forms of theory", being the conditions of theoretical thinking, may be "pictured" or represented by certain "multiplicities" or manifolds describable by concepts deriving from topology. The question of spatial structures in which thinking takes place and the question of how various spaces differ from one another become a matter of importance, perhaps even of a fundamental theoretical importance.

Hence, a question arises about the limits of applicability of this strategy. Is it applicable to deductive theory only, or to any academic theory, or perhaps to all rational thinking? Finally, would it be possible, perhaps, to extend this form of representing thinking conditions to any act of consciousness, i.e. to what we call thinking in general? This would mean, however, that that multiplicity we are asking about, as well as its topology, are equivalent to a certain level of – or perhaps to the whole of? – the structure of consciousness which is studied by a phenomenologist when he turns away from the intentional object itself and towards the act.

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Nikolay Milkov
Wittgenstein's Ways
Aristotle first investigated different modes, or ways of being. Unfortunately, in the modern literature the discussion of this concept has been largely neglected. Only recently, the interest towards the concept of ways increased. Usually, it is explored in connection with the existence of universals and particulars. Some authors claim that universals, the shape of my house, for example, are simply different ways in which its building blocks (the particulars) are ordered. Another group of metaphysicians focuses attention on the relation between universals and particulars. Well-known conception is that it is a relation of supervenience that eschews reductivism. In the last few years the relation between universals and particulars was also explored with the help of the concept of grounding.The approach we are going to follow in this paper is different. It discusses Wittgenstein's Tractarian conception of higher ontological levels as ways of arranging elements of lower ontological levels. In the *Tractatus*, Wittgenstein developed his ontology of ways (*Art und Weise*) in six steps: (i) Constructing states of affairs out of objects; (ii) Constructing propositions out of states of affairs; (iii) Constructing propositional signs; (iv) Constructing thoughts with the help of propositional signs; (v) Constructing truth / falsity; (vi) Constructing works of art.Wittgenstein's Tractarian ontology remained ontology of one world, in opposition to the ontology of many subordinated worlds of his teachers Frege (the author of the conception of three worlds) and Russell (the author of the Theory of Types): the transition from one ontological level into another, higher level doesn't mean a transition from one world into another. This is the main advantage of Wittgenstein's constructivist ontology of ways: it makes the belief in emergence of new worlds redundant. Another its advantage is that it

suggests a tangible, topological, solution of the problem.

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Thomas Mormann

(De)constructing Points: From Topology to Mereology and Back

Points are considered as fundamental ingredients of topology spaces. For instance, a topological space is defined as a set X of "points" endowed with some "topological structure" encapsulated in the set OX of open subsets of X, OX being a subset of the power set PX of X. The set OX of open sets of a topological space has the lattice-theoretical structure of a complete Heyting algebra. As is well known, many basic concepts of topology can actually expressed without points, but using only the lattice-theoretical structure of OX only, for instance continuity and connectedness. This has led to what has been described as "pointfree topology". Indeed, pointfree topology may be characterized as a kind of non-classical mereology based on systems of regions exhibiting the structure of complete Heyting algebras instead of Boolean algebras as is the case for classical mereology. On the other hand, given an appropriate (pointfree) Heyting mereological algebras H, it is possible to construct for H a set of ersatz points pt(H). This set pt(H) may be endowed with a canonical topological structure O(pt(H)) isomorphic to H. In this way, under some mild restrictions, topological spaces and mereological systems may be considered as equivalent.

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Stefano Papa

Time Granularity and the Formal Ontology of Time-Awareness. A Husserlian Argument for a Topology of Temporal Information

The Phenomenological Analysis of Inner or Immanent Time-Consciousness is meant to make explicit structural dependencies in the field of predication and imagination. Reasoning about temporal information (which is central in modern systems of temporal logic) is touched upon only insofar, as an explication of abstractive reflection itself can be made available. Husserl proposes a fourfold sense of „absence“ in his analysis of temporal awareness: .“representation“; what is here absent, is the object denoted by a predication. Representation is dependent upon imagination. An object absent in an act of imagining is „vacant“ in the sense that the item itself is not to be retrieved by imagining it. Vacancy itself is dependent upon a third more radical absence, the absence of Time-Consciousness. Absence in this third sense is to be further explicated as awareness of time as immanent duration and inner sequence of given items. The methodical points of view which are operational in the interpretaion of temporal awarenes, and are to be applied to the experience of linear ordering of information items (for example, a musical gestalt); are the ones of the formal ontology developed in the Logical Investigations. The expressions „stream in a stream“, or „transcendence in the immanence“ (in Cartesian Meditations, with an eye to intersubjectivity), or else „living present“ are metaphorical. They point to the fourth sense of absence.
From the point of view of Phenomenology, the formal methods used in contemporary logics to model temporal reasoning are idealizations and abstractive formalizations, onesidedly founded in the above mentioned structures of dependency. As an example of such idealizations, one could mention Kamp’s theorem: the definability of all temporal operators in terms of „since“ and „until“, is bound to the condition that „time“ is interpreted as a continuous linear ordering. Indipendently from the completeness-result, this theorem is important also because it poses the issue of referring to the same language to describe a situation with respect to different temporal scalings (granularity).Time granularity is linked to semantic properties of representation systems. In contemporary logics it is formally treated by defining an algebra for granularities (set-theoretical approach) and by combination of simple temporal logics into a system for time granularity (logical approach). At this point, however, phenomenological considerations could motivate a shift in the study of time granularity: Since, as stated above, time-awareness is an eidetic layer to be abstracted from the

presentation of some sequential items (melody), frames (algebras) as formalizations of finite operations have a shortcome, because they don't contain a formalization of what they might be about (but this might be at the root of the problems posed by granularity, as illustrated by the synchronization problem). This situation can be changed by enriching a given frame (operations) with a set of points (observations), and a subset of their cartesian product. This construction is called a topological system. The introduction of a topology has thus been motivated by phenomenological considerations on time-awareness and its structural role in systems of formal representation. That is, the aim of this paper is to vindicate a systematic function of phenomenological reflections for the representation of formal categories in a given formalized system.E. Husserl, *Logical Investigations* (J. Findlay). 1970

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Marek Piwowarczyk
Problems with extension

In my talk I want to examine the ontological status of extension, analyze the problem of infinite regress entangled in the concept of extended object and take a look at possible solutions to the problem.

Extension is an essential structural property consisting in having parts which lie outside each other. Each part is also extensive so we have a vicious regress. In order to avoid it we can: (1) postulate non-extensive beings which compose extensive ones; (2) say that the regress is not vicious (gunk theory); (3) postulate objects composed of parts dependent with respect to their extension on wholes (I call them "primordially extended objects"); (4) postulate extended simples. I try to show that no solution is satisfactory.

Tomasz Placek
Bifurcating universes without bifurcating paths

This talk is a part of a larger argument for studying possible evolutions of individual objects rather than possible evolutions of an entire universe in investigations concerning determinism. The talk draws one's attention to an odd phenomenon in the initial value problem of general relativity: each object (massive or mass-less) has a unique and well-defined possible evolution (geodesic), whereas a given 3-dimensional space has more than one possible development (i.e., Lorentzian 4-dimensional spacetime satisfying Einstein field equations). Moreover, the union of these non-isomorphic developments forms a non-Hausdorff manifold; the manifold does not permit bifurcating geodesics, however. These features have consequences for a project of defining possible histories in topological terms, for instance, as maximal Hausdorff sub-manifolds of some master manifold that captures all historical possibilities.

Ian Pratt-Hartmann
A Skeptical Look at Region-based Theories of Space

One of the many achievements of coordinate geometry has been to provide a conceptually elegant and unifying account of spatial entities. According to this account, the primitive constituents of space are points, and all other spatial entities—lines curves, surfaces and bodies—are nothing other than the sets of those points which lie on them. The success of this reduction is so great that the identification of all spatial objects with sets of points has come to seem almost axiomatic.

For most of the previous century, however, a small but tenacious band of authors has suggested that more parsimonious and conceptually satisfying representations of space are obtained if we adopt an ontology in which regions, not points, are the primitive spatial entities. These, and other, considerations have prompted the development of formal languages whose variables range over certain subsets (not points) of specified classes of geometrical structures. We call the study of such languages `mereogeometry'.

In the past two decades, the Computer Science community in particular has produced a steady flow of new technical results in mereogeometry, especially concerning the computational complexity of region-based topological formalisms with limited expressive power. The purpose of this talk is to provide a conceptual framework for assessing the philosophical significance of this work. As usual, to grasp the philosophy, one first needs to master the mathematics.

Peter Simons
Connectedness and Ontological Unity
A topological space is path connected when any two points are connected by a line. This definition, more intuitive than the standard definition of connectedness, goes over neatly to graph theory. It is argued that it is the concept we need to make sense of the notion of a unified or single entity. Some mereological theories assume that any collection of objects comprise a whole. This lets in cross-categorical and gerrymandered entities and it is argued that, contrary to many ontologists' views, it renders mereology non-innocent. To retain a useful, more restrictive but still very general notion of a natural or integrated whole, generalised connectedness is precisely the notion we need.

Bartłomiej Skowron
Perzanowski's Combination Ontologic in Hilbert's Cube
Perzanowski's combination ontologic is the ontology of elements and their combinations. Perzanowski, after Leibniz, concluded that combinations are defined by the internal features of the elements which define the structure of connections between the elements, i.e. whether one element is connected with another depends on the elements' insides. We present the view that the structure of the combination depends firstly on structural, topological and a priori forms and then it can be determined by the features of elements. We suggest enriching the structure of the ontological universe by its topologisation. The examples of ontological worlds presented here prove that this is sensible and necessary. By modelling the ontological universe with the use of Hilbert's cube we show the relations between the notion of dimension and the notions of situation and a possible world. We also put forth a new interpretation of ontological rationalism.

Achille Varzi
The Boundaries of Things: Where Topology Meets Metaphysics
Philosophical reflections on the topological notion of boundary tend to focus on the opposition between boundaries as basic, lower-dimensional entities and boundaries as derived, higher-order abstractions. This opposition reflects two fundamentally different ways of understanding the structure of space and time and has important ontological consequences when it comes to the structure and nature of those entities that may be said to be *located in* space and time, such as objects and events. There is, in addition, a second important distinction that may be drawn, and whose ontological ramifications extend even further—the distinction between natural (or *bona fide*) and artificial (or

fiat) boundaries. The former are just the natural boundaries of old, as grounded in some factual discontinuity or qualitative heterogeneity betwixt an entity and its surroundings; the latter are exemplified especially by boundaries induced through human cognition and social practices and lie skew to any objective differ¬entiations in the underlying wordly material (as with the contours in a Seurat painting, or the borders of Wyoming). The distinction bites deeply, for it can be drawn across the board: not merely in the domain of boundaries but also in relation to those entities that may be said to have boundaries. If a certain object or event enjoys a natural boundary, its identity and survival conditions do not depend on us; it is a *bona fide*, mind-independent entity of its own. By contrast, if its boundary is of the artificial sort, then the entity itself is to some degree a *fiat entity*, a product of our worldmaking. Now, we may disagree on which entities are of which sort, and any such disagreement will reflect a corresponding disagreement in matters of metaphysical realism. Indeed, it can be argued that the question of realism is, in an important sense, the question of what are the bona fide boundaries, the boundaries that "carve at the joints". Here I am especially interested in limit case: What if there aren't any? What if all boundaries—hence all entities—were on closer look and to some extent the product of some cognitive or social *fiat*?