David I. Spivak

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Education

Ph.D. Mathematics, University of California, Berkeley, 2007.

Advisor: Peter Teichner.

Thesis title: Quasi-smooth derived manifolds.

B.S. Mathematics, University of Maryland, College Park, 2000.

Employment

University of Oregon, Mathematics: Paul Olum Visiting Assistant Professor. 2007-present.

University of Oregon, Computer Science: guest instructor. Spring 2008, Fall 2008.

University of California, Berkeley: Graduate Student Instructor. 2001-2005, 2006-2007.

University of California, Berkeley: Graduate Student Researcher. 2005-2006.

University of Maryland, College Park: Strauss Teaching Assistant. 1999-2000.

Grants

Office of Naval Research grant N000140910466, in the amount of $100,000 per year for three years (2009-2011).

Honors and awards

Outstanding Graduate Student Instructor (UC Berkeley 2002).

VIGRE fellowship (UC Berkeley 2000-2001).

Graduated Magna Cum Laude, and with Honors in Mathematics (U. Maryland 2000).

Outstanding Senior Award (U. Maryland 2000).

Carol Karp award for Outstanding Logic student (U. Maryland 2000).

Publications

Journal Articles

P. Batra, B.A. Dobrescu, D.I. Spivak. "Anomaly-free sets of fermions." *Journal of Mathematical Physics*, **47**, 082301 (2006).

D.I. Spivak. "Derived Smooth Manifolds." To appear in *Duke Mathematical Journal* (April 2010, tentatively). ePrint available: `http://arxiv.org/abs/0810.5174`

D.I. Spivak. "Simplicial Databases." Submitted to *Mathematical Structures in Computer Science*. ePrint available: `http://arxiv.org/abs/0904.2012`

D. Dugger, D.I. Spivak. "Rigidification of quasi-categories." Submitted to *Mathematische Zeitschrift*. ePrint available: `http://arxiv.org/abs/0910.0814`

D. Dugger, D.I. Spivak. "Mapping spaces in quasi-categories." Submitted to *Mathematische Zeitschrift*. ePrint available: `http://arxiv.org/abs/0911.0469`

D.I. Spivak. "Higher-dimensional models for networks." Submitted to *Mathematical Structures in Computer Science*. ePrint available: `http://arxiv.org/abs/0909.4314`

D.I. Spivak. "Sequential sets in Topology." In preparation.

Invited Presentations

Derived Manifolds:
Derived Algebraic Geometry conference (U. Salamanca, Spain) 2009/06/04;
U. Quebec at Montreal 2009/05/22;
MIT 2009/05/04;
U. California, Riverside 2009/04/30;
Stanford U. 2009/02/03;
Cascade Topology Conference (Portland State U.) 2008/11/08;
U. Illinois Urbana Champaign 2008/10/04;
AMS Sectional (U. British Columbia) 2008/10/04;
CATS3 conference (Pisa, Italy) 2008/09/03.

Categorical and topological methods in Computer science:
Carnegie Mellon U. 2009/11/13;
Agent-based complex systems conference (IPAM) 2009/10/13;
McGill U. 2009/05/19;
U. California, Riverside (colloquium) 2009/04/29;
Algebraic Topological Methods in Computer Science (U. Paris 7) 2008/07/07;
U. Oregon 2008/05/06;
U. Oregon Computer Science Department (colloquium) 2008/02/07.

Mapping spaces in Quasi-categories:
U. Illinois Chicago 2009/12/09;
U. Pennsylvania 2009/11/18;
Novemberfest Category theory conference (Carnegie Mellon U.) 2009/11/15;
AMS sectional (U. California, Riverside) 2009/11/08.

Teaching Experience

Graduate classes at U. Oregon:
Characteristic classes – Fall 2008
Model categories and simplicial sets – Spring 2010.

Undergraduate classes at U. Oregon:
Integral calculus – Fall 2008
Calculus III (sequences and series) – Winter 2009
Differential equations – Winter 2009, Fall 2007
Linear algebra – Spring 2010, Winter 2008
Discrete Mathematics – Fall 2007.

Undergraduate classes at U. California, Berkeley
Precalculus (large lecture, with TAs leading sections) – Spring 2005, Fall 2004
Other undergraduate classes, akin to those at U. Oregon (as a TA) – Fall 2001 to Spring 2007.

Related Professional Experience

I was on the organizing committee for the "Agent-based complex systems" conference at the Institute of Pure and Applied Math, October 12-14, 2009.

As part of the ONR grant, I hired two graduate students to implement my work on Simplicial Databases as working code. (Spring 2009-Spring 2010).

I have led two seminars on in the Computer and Information Science department at the University of Oregon. They were called "Category theory in computer science" (Spring 2008) and "Mathematical methods in computer science" (Fall 2008).

I tutored math graduate students with disadvantaged backgrounds by volunteering for the Mathematics Opportunity Committee at UC Berkeley, 2002-2003.

Research Experience

Derived manifolds

I defined a category of derived manifolds, containing the category of smooth manifolds. In it, submanifolds $A, B \subset X$ can be intersected as geometric objects, without first making them transverse, in such a way that their fundamental classes satisfy the expected cup product formula $[A \cap B] = [A] \cup [B]$ in $H^*(X)$. This research relied heavily on ideas from derived algebraic geometry. Tools included model category theory and synthetic differential geometry.

Quasi-categories

(Joint with Dan Dugger). We developed new tools for computing the mapping spaces in a quasi-category, and used them to give another proof of the Quillen equivalence between quasi-categories and simplicial categories.

(Joint with Peter Bubenik). We have conceived of a new homotopical notion of directed topological spaces, and we are attempting to prove that it has a model structure which is Quillen equivalent to that of Quasi-categories.

Quantum Physics

(Joint with Puneet Batra and Bogdan Dobrescu.) Integer solutions to the equations

$$x_1^3 + x_2^3 + \cdots + x_n^3 = 0$$
$$x_1 + x_2 + \cdots + x_n = 0$$

represent sets of Fermions that are *chiral*. The physicists (Batra, Dobrescu) wanted solutions in which $x_i + x_j \neq 0$ for all i, j, and in which both n and $\max(|x_n|)$ were as small as possible. I showed that the above problem can be tackled using well-known techniques for finding short vectors in an integral lattice.

Categorical and simplicial methods in computer science

The world of today is not just physical, it is informational. We need to rethink what information is, as well as how to effectively organize and process it. Category theory and algebraic topology provide a rigorous mathematical framework in which to ground this study. For example, I have described databases as sheaves on simplicial sets (akin to schemes in algebraic geometry) and networks as fuzzy simplicial sets.

Topology

In other work in topology and category theory, I found a new link between simplicial sets and the so-called sequential spaces. Sequential spaces are generated by a single topological space, the convergent sequence $\{\frac{1}{n} \mid n \in \mathbb{N} \cup \{\infty\}\} \subset [0,1]$ in the unit interval. Despite having only a single generator, they are quite general: they include all Hausdorff spaces and all finite spaces. The category of sequential spaces is a reflective subcategory of the category of M-sets (i.e. sets with a right M-action) for a certain monoid M, a monoid which also governs the behavior of simplicial sets. Using these ideas, I can give a conceptual way to understand Drinfeld's proof that geometric realization commutes with finite limits.

References

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