

PhD research topic proposal

BME, Doctoral School of Mathematics and Computer Science

Name and degree of supervisor :

Pintér Gergő, PhD

Are you willing to supervise Stipendium Hungaricum applicants?

Yes, but only if I am included in the admission process.

Title of the topic:

Quantum mechanics meets topology and singularity theory

Short description:

This topic includes topological and singularity theoretical aspects of the degeneracy points of physical systems. These systems are described by a parameter dependent family of matrices (e.g. the Hamiltonian map in the case of quantum systems), with coincident eigenvalues at certain points, which are called degeneracy points. The characterization of the degeneracy naturally leads to singularity theoretical methods. The topology has had a revolutionary influence in this area in recent decades, and we expect a similar one from singularity theory.

The PhD topic mainly focuses on the mathematical questions appearing in this area, but the physical counterpart is available from the physicist research group of András Pályi. A systematic description of the mathematical model is also a part of this work.

These articles serves as reference, however they are written from physicist perspective:

<https://arxiv.org/abs/2407.10478>

<https://arxiv.org/abs/2202.05825>

<https://arxiv.org/abs/2012.14357>

<https://arxiv.org/abs/2302.08241>

And a talk for mathematician:

<https://video.renyi.hu/video/equivariant-contact-equivalence-applied-in-condensed-matter-physics-791>

<https://video.renyi.hu/video/degeneracy-points-of-quantum-systems-from-a-singularity-theoretical-approach-380>

Requirements: The field of interest of the students have to overlap with the following areas:

- Differential geometry and topology (manifolds, bundles, homotopy and (co)homology theories, characteristic classes, curvature, Lie group actions)
- Algebraic (local analytic) geometry, singularity theory (classification of map germs, local algebras, matrix varieties, 'catastrophe theory')
- Physics (quantum mechanics, solid state physics, superconducting, quantum computing)

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Place of work:

