PhD thesis proposal

Algebraic Geometry

Keywords: Algebraic Geometry

1. Project background

Electrical Impedance Tomography is a medical imagery technique that measures the current in response to a voltage difference applied to points on the exterior of the body. Medical imagery is essential to diagnostic medicine, and Electrical Impedance Tomography offers considerable advantages: unlike X-rays, PET scans or MRI, it does not expose the patient or personnel to potentially harmful radiation or require large high-power equipment. Additionally, it costs relatively little to operate, and it can be performed quickly using a small portable device, some of which could be transported in ambulances, making it possible to rapidly diagnose certain medical emergencies.

The reason that Electrical Impedance Tomography is not in widespread use is that the resolutions it offers are too low to be useful in medical imagery. From a mathematical point of view, reconstructing the properties of the tissue from measurements performed outside the body is called an inverse problem. Addressing this inverse problem to improve resolutions and processing time in EIT could thus allow the development of a new essential tool for medical imaging.

2. PhD project

The project will develop tools of algebraic geometry, linked with the study of Riemann surfaces used to model hearts and lungs in EIT. Riemann surfaces, seen as complex algebraic curves, are now understood as being the first pieces of the partly conjectural theory of motives due to Grothendieck. One of Grothendieck's standard conjectures is that motives can be decomposed into smaller pieces, as complex algebraic curves can be decomposed (through cohomology) into a constant part and its Jacobian part. This is the so-called Chow-Künneth decomposition. The main problem we want to address in this Ph. D. project is to extend the known results about this decomposition.

3. Candidate profile

The candidate should have a master in mathematics. He/she has to show sufficient knowledge in some (but not necessarily all) of the following topics:

- Algebraic geometry,
- Intersection theory,
- Homological algebra.

The PhD position is for a full time research contract of 3 years (about 1900 euros/month gross salary), with a possibility to have complementary part time teaching appointment.

4. Application

This research project, including the PhD salary, will be funded by the "EITAG" project, a research grant funded by the region Bourgogne Franche-Comté, the Feder Bourgogne and the graduate school EIPHI.

For applying, send a single pdf-file **BEFORE END OF MAY** including:

- Curriculum Vitae
- Short summary of the final year or master's thesis
- Suggestion of two referees with contact details
- Detailed explanation justifying your choice for this PhD project to:

Frédéric Déglise: frederic.deglise@u-bourgogne.fr

(webpage: http://deglise.perso.math.cnrs.fr/)

5. References

1. Fulton, William. Intersection theory. Second edition. Ergebnisse der Mathematik und ihrer Grenzgebiete. 3. Folge. A Series of Modern Surveys in Mathematics [Results in Mathematics and Related Areas. 3rd Series. A Series of Modern Surveys in Mathematics], 2. Springer-Verlag, Berlin, 1998. xiv+470 pp.
2. Murre, Jacob P.; Nagel, Jan; Peters, Chris A. M. Lectures on the theory of pure motives. University Lecture Series, 61. American Mathematical Society, Providence, RI, 2013. x+149 pp.
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