

## Report MITP Topical Workshop

### Applied Newton-Cartan Geometry

March 12 – 16, 2018

#### Organizers:

1. **Eric Bergshoeff (University of Groningen)**
2. **Niels Obers (Niels Bohr Institute, Copenhagen)**
3. **Dam Thanh Son (University of Chicago)**

#### Aim of the workshop:

The aim of this interdisciplinary topical workshop was to advance the recent exciting applications of Newton-Cartan geometry in different directions and to enable participants from different backgrounds (condensed matter physics, mathematics, statistical physics, gravity and string theory) to interact and exchange new ideas. The first such topical workshop was organized at the Simons Center for Geometry and Physics in Stony Brook (USA) in March 2017. The Simons workshop was a huge success and led to many contacts across different disciplines which otherwise would never have been established. The aim of the Mainz workshop was to repeat the success of the Simons workshop and keep the momentum in this growing research field, by organizing a similar topical workshop in Europe.

#### Review of the workshop

The schedule of the workshop consisted of a number of 60 minutes overview talks, which were given at the beginning of each day, plus a number of 45 minutes and 30 minutes presentations. Between and after the talks there was ample time for informal discussions.

The week started with an overview of Newton-Cartan Geometry by Roberts (Imperial College). On the same day there were interesting talks from the mathematical point of view about a twistor formulation of Newton-Cartan spacetimes (Dunajski, Cambridge) and from the physics point of view about higher-spin extensions (Gruemiller, Vienna). The day was closed with an informal welcome reception.

Tuesday started with an overview talk by Hořava (Berkeley) about nonrelativistic naturalness thereby putting the issue of non-relativistic physics in a somewhat wider perspective. Other interesting talks that day were by van den Bleeken (Istanbul) pointing out that the conventional Post-Newtonian approximation allows a natural extension to include so-called twistless torsion and by Petropoulos (Paris) about Carrollian hydrodynamics.

On Wednesday Hartong (Edinburgh) gave an interesting overview talk on non-relativistic holographic dualities and the role of non-relativistic strings. Other particularly stimulating talks were the one by Grosvenor (Copenhagen) about recent coset constructions of non-relativistic geometries and the one by Moroz (Munich) on a specific application of Newton-Cartan geometry to effective field theory in a condensed matter setting.

Thursday opened with an inspiring overview talk by Taylor (Southampton) about BMS symmetries for AdS spacetimes leading to many interesting discussions. Noteworthy talks that same day were the one by Pena-Benitez on Non-Relativistic Scaling in Semimetals and the one by Puletti on Entanglement entropy in generalized Quantum Lifshitz theories. The day was closed with a social conference dinner at a local restaurant in town.

The last day of the workshop started with an overview talk by Rosseel on non-relativistic supergravity which gave hope that non-relativistic supersymmetry may play a crucial role in calculating the exact partition function of a

non-relativistic supersymmetric field theory. That same day both Figueroa-O'Farrill (Edinburgh) as well as Prohazka (Bruxelles) gave talks about specific features of (non-relativistic) kinematical Lie algebras.

Overall, the workshop featured a highly communicative atmosphere along with an active participation of all participants. It has strengthened already existing networks of collaboration, widened the field of interested researchers, and, moreover, the workshop has led to new collaborations and exchanges. It is also noteworthy to mention that there was a healthy age distribution, ranging from more senior professors to junior faculty and postdocs all the way to younger PhDs, showing that this field is also attracting and stimulating the next generation of researchers. Finally, a proactive effort was made to make sure that there was not only diversity in age, but also in gender, which led to a (relatively) high fraction of female participants and speakers.

## Conclusions

The Mainz workshop showed that the field of Applied Newton-Cartan Geometry is currently a rapidly developing field which is attracting researchers from different directions, that are inspired to contribute to uncovering the many possible interconnections and applications. New directions were set in motion at the workshop like novel applications of massive gravity in the Fractional Quantum Hall Effect, the role of hydrodynamics without boost invariance and new applications of torsion in holography and condensed matter physics. Moreover, in the directions that were already under investigation (such as non-relativistic gravity theories, including supersymmetry, relations to non-AdS holography and string theory, connections to novel algebras and symmetry structures, effective field theories) further progress was made thanks to the lively interaction at the workshop.

There is no doubt that the Mainz workshop has given a significant boost to this emerging field and its cross-disciplinary opportunities. Plans to organize a third workshop Applied Geometry are under way.