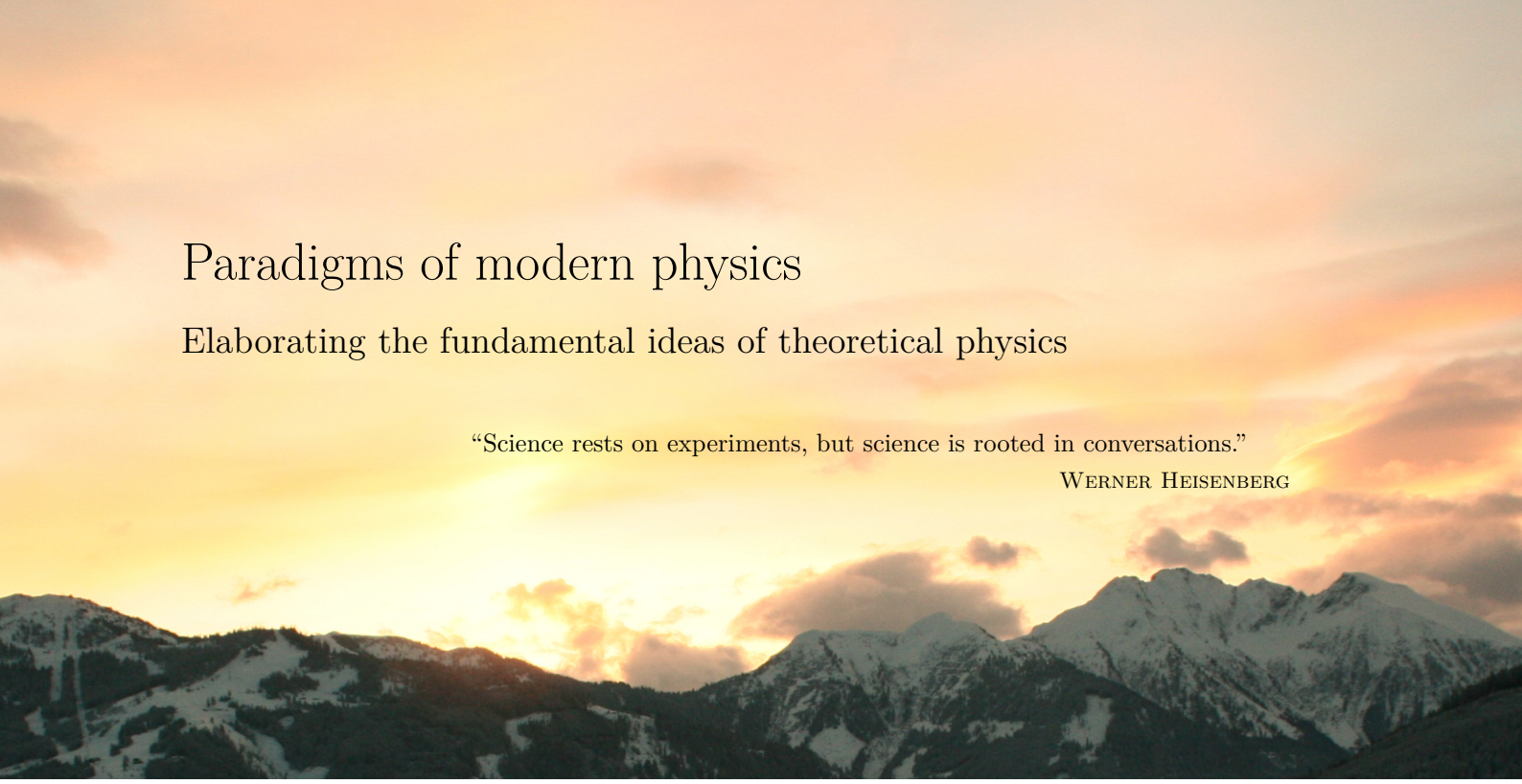

Paradigms of modern physics

Elaborating the fundamental ideas of theoretical physics

"Science rests on experiments, but science is rooted in conversations."
Werner Heisenberg

View from the location of the workshop

Invitation: Workshop, March 22nd-29th 2014

Dear colleagues and fellow students,

A physical theory is not merely a mathematical formalism together with rules which connect the formalism to experiments and experience. It also consists of a set of paradigms, i.e. a specification of "the kind of questions that are supposed to be asked and probed for answers" (Kuhn) and a set of mathematical and physical ideas which represent the essence of the theory.

We consider it an important task to discuss the paradigms of modern theoretical physics, in particular of quantum theory, quantum field theory and gravitation in an informal, creative and open environment. To this end, we would like to invite you to join us for a mountain cabin workshop in the alps from the 22nd till the 29th of March 2014. The following points constitute the focus of the discussion:

A) **Identification of the paradigms behind QT, QFT and GR**
   - Which paradigms exist?
   - Which conceptual and historical origin do they have?
   - Which mathematical structures correspond to those paradigms?

B) **Confrontation of the paradigms**
   - To which extent are the paradigms of the different theories compatible?
   - Which role do they play in our own work and way of thinking?

C) **Creative and open discussion on the transcendation of the paradigms**
   - Which possibilities arise in omitting, interchanging and transcending the paradigms?
   - Which mathematical structure allow for the implementation of new and different paradigms?

Structure of the workshop: Each participant prepares a talk of approximately 30-45 minutes on a topic of choice which fits into the theme of the workshop. After each talk, there is room for discussion within which specific questions are fixed and small groups are formed which work on particular questions. The results of the groups, independent of their nature, are presented to all participants in an evening session. In order to promote a feeling for the questions which could be discussed, we have attached a small collection of exemplary topics. These topics are rather general in nature, the talks and discussions should focus on concrete questions and problems. Please note that:

- There will be ample time to enjoy the lovely mountain atmosphere.
- The talks should focus on problems, examples or paradigms of modern theoretical physics. Whereas they may or may not be of philosophical relevance, they have to be debatable from a physical or mathematical point of view (i.e., should not only be of philosophical nature).
- The talks and discussions should not merely study approved results from the literature, but also focus on unusual thoughts and open problems.

The workshop takes place from the 22nd to the 29th of March 2014 in a mountain cabin near Dorfgastein (south of Salzburg in Austria). We will have to cook for ourselves. To this end, we divide up into cooking teams of two or three to prepare breakfast, lunch or dinner.

Registration details:

- The workshop is aimed at PhD students or master students (in exceptional cases).
- An acquaintance with modern theoretical physics is required.
- Travel details: Arrival on Saturday the 22nd of March 2014. A shuttle is available from the Dorfgastein train station to the cabin until 4pm (beware of frost and ice). Please state if you want to team up for a joint travel from Munich (departing time in Munich would be approx. noon). Departure: Saturday the 29th.
- Cost for accommodation and food (for 7 nights): approx. 250 Euros. (We are still looking for sponsors in order to reduce the costs.)
- Due to the number of beds in the cabin, the number of participants is restricted to 20.

Applications will be accepted until the 20th of December 2013. Please register via email to ParaModPhys@mathematik.uni-regensburg.de and include the following information:

- A brief motivation
- Your main area of interest
- Your current occupation (PhD student, master student, Post Doc, ...) and institution
- The title of a talk you would like to give (multiple proposals possible!)
- Other information (such as allergies, dietary specification, etc.)

With best regards,

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Attachment: Exemplary topics

In order to promote a feeling for the topics which could be discussed in the workshop, we have listed a small number of suggestions here. Which topics are discussed and treated completely depends on the proposed talks. In other words, talks about topics not on this list are very welcome!

LOCALITY

Since the experimental verification of Bell's theorem, it has become clear that reality is non-local. Nevertheless, locality is one of the essential assumptions of Special and General Relativity. Is the "status quo" of physics, which is based on the fact that there is superluminal spreading in Quantum Theory, but no superluminal transmitting, a satisfactory solution? Is this solution compatible with the search for a more fundamental theory?

TIME

The existence of external time is one of the most basic paradigms in physics, but it is already debatable in light of Special and General Relativity. Is this an indication that time is only an emergent phenomena, as arguably indicated by Loop Quantum Gravity (compare the 'problem of time' in LGQ)? Can a sensible theory which does not incorporate time even be conceived of? How does the subjective 'Now' of our experience relate to such questions?

SUBSYSTEMS

Entanglement of states in Quantum Theory questions the idea that bigger systems are composed of smaller subsystems. The same issue arguably occurs in General Relativity where the non-linearity of the Einstein Eq. prevents a simple decomposition of systems into subsystems. Nevertheless, it seems that our calculations can only ever involve subsystems. Are we thus bound to conceive only theories which allow an effective description of subsystems? Or is this a paradigm which we could dispose of?

SMALL COMMON SET OF CONCEPTS

Most of our physical theories are based on a small common set of concepts such as energy, field, particle, mass, etc. Are those concepts necessary? Are they fundamental or are they only auxiliary tools to describe nature?

VARIATIONAL PRINCIPLES

Many equations of fundamental physics can be derived from variational principles, and the search for new theories (and modification of existing theories) is in many cases based on variational principles. Is the reason for this pragmatic in nature or paradigmatic? Can and should variational principles be motivated ontologically? Or are they, again, mere mathematical tools?

AXIOMATIZATION

Physicists often seek an axiomatization of working theories. In the case of QFT, e.g., there are severe problems in doing so. The question arises if an axiomatization is always sensible or necessary, and whether it should be assumed that the "right" theory should be such that it can be axiomatized?
Is it possible that the search for an axiomatization constitues an obstacle in the search for more fundamental physics? How much can be gained if explanans and explanandum are exchanged in the process of axiomatization? (E.g. "Does entropy grow with time or does time flow along the growth of entropy?")