

Fundamental Physics at the Crossroads

22 – 26 February 2020 Lorentz Center @Oort

This Lorentz Center workshop was organized in honour of the 2020 Lorentz Professor in Leiden, Prof. Gia Dvali. Its main theme was a discussion of the cross-roads at which fundamental physics finds itself today: the Standard Model of particle physics is extremely successful; however, we know that some new physics exists. Yet, as of today we have no confirmed prediction for where and how to search for it. This workshop brought together experts in cosmology, Early Universe, particle physics theory and phenomenology to search for new ideas and the way to go.

The workshop fulfilled its scientific goal. The presentations with follow-up discussions covered essentially all relevant directions from the most fundamental theoretical aspects to the current experimental situation and future prospects. Virtually every topic became a subject of intense discussions (that in some cases transformed into research projects).

A big part of the discussion was about dark matter both from the point of view of theoretical beyond the standard model (BSM) theories as well as the current experimental constraints and prospects for direct and indirect detection of dark matter. Another important topic that became a subject of heated discussions was naturalness and in particular the status of the so-called Hierarchy Problem in the Standard Model of particle physics. Many arguments pro and contra were presented and defended. In particular whether this problem should be a guiding principle for future searches for BSM physics at colliders and beyond.

Some extremely widely discussed ideas were black holes in gravity and similar states in Quantum Chromodynamics (QCD). Several BSM models such as left-right extensions of the Standard Model were presented and discussed.

Cosmology and its implications for fundamental physics was another big focus of the workshop. In particular, the status of the inflationary paradigm and possible improvements on observations. Ideas about formation of primordial black holes as dark matter candidates were also presented.

Another topic was minimal extensions of the Standard Model and whether minimality must be a guiding principle in the search for new physics. Very interesting ideas on future accelerator technologies such as wake field acceleration were presented and discussed. It was pointed out that such accelerators are especially valuable for the search for new physics with large cross-sections at high center-of-mass energies such as micro black holes.

The workshop was organized with relatively few talks and ample time for questions and discussion. The first four days each focused on one broad theme, starting with a long talk plus discussion. Discussions started already before this first lecture and invariably continued during the lunch break. This was followed by two or three shorter talks in the afternoon, with a long wrap-up discussion at the end of the day. All in all, more than half of the available time at the Lorentz Center was dedicated to discussions, and these were very animated, continuing in smaller groups over dinner. The final day had a single lecture followed by a long discussion and summary.

Overall, the workshop turned out to be a great success, and several participants contacted the organizers after the workshop to express their enthusiasm. It became clear that such format with intense informal discussions and debates is extremely useful and should be adopted much more widely in the future.

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