Executice Summary of the MITP Topical Workshop/Scientific Program: "Indirect Searches for New Physics Across the Scales"

Benjamin R. Safdi (Univ. of Michigan, Ann Arbor)
Tracey Slatyer (MIT)
Yotam Soreq (CERN)
Joachim Kopp (CERN / JGU Mainz)

17 June – 12 July, 2019

Goals of the Topical Workshop/Scientific Program

In spite of tremendous technological advances and groundbreaking experimental developments, direct searches for extensions of the Standard Model have come up empty so far. In particular, no new particles or forces have been found yet at the LHC, in dark matter searches, or in low-energy precision experiments. In resolving the fundamental shortcomings of the Standard Model of particle physics, we must therefore cast a wider net by looking for new physics at energy scales that have been ignored so far and by exploiting more subtle, indirect, signatures.

In this context, the goal of the MITP program "Indirect Searches for New Physics Across the Scales" was to explore novel strategies for searching for physics beyond the Standard Model, with special focus on interdisciplinary work.

Scientific Highlights of the Topical Workshop/Scientific Program

One of the conclusions of the workshop was that new astrophysical data sets offer tremendous new opportunities for dark matter searches: precision observations of stars are sensitive to dark matter-baryon scattering; gravitational lensing of fast radio bursts (FRBs) can be exploited to search for primordial black holes; the ANITA neutrino telescope probes dark sectors using the highest-energy neutrinos; and x-ray signals from neutron stars may provide a glimpse of axion dark matter. Overall, the talks and discussions at the workshop revealed that, after detailed scrutiny, dark matter candidates beyond conventional WIMPs appear much more viable and better motivated than a couple of years ago. Among the new contenders for explaining the dark matter in the Universe are axions, primordial black holes, very weakly interacting particles with sub-GeV masses, and novel types composite objects.

Besides phenomenological studies related to dark matter, another focus topic of the workshop were new models of dark matter, motivated by the changing data landscape.

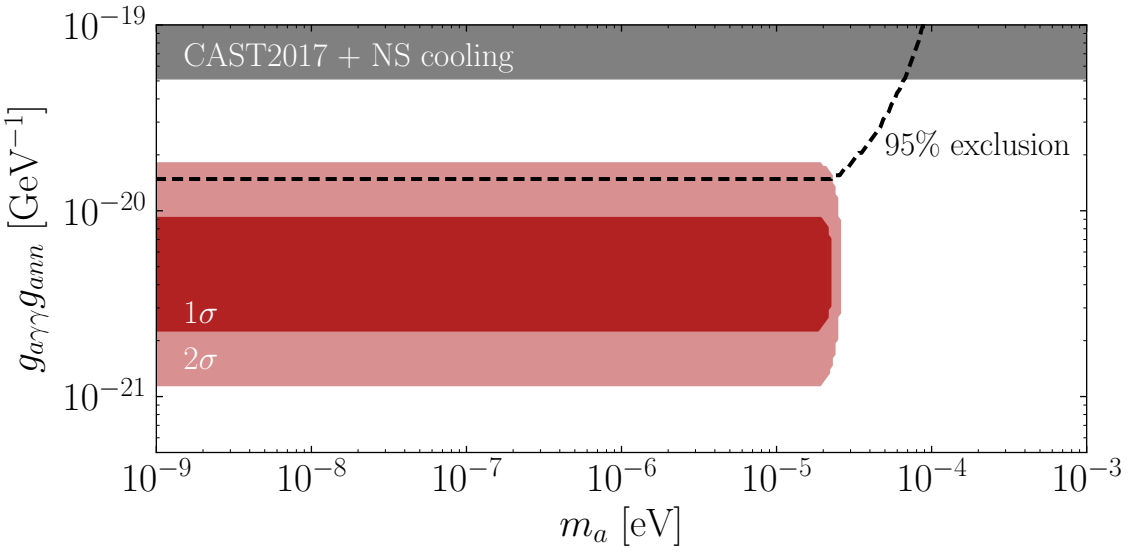

Figure 1: X-ray signals from neutron stars can be interpreted as hints for axion dark matter. Figure adopted from Buschmann et al., arXiv:1910.04164.

Beyond the hunt for dark matter (but possibly connected to it), precision experiments in atomic physics are emerging as a new tool for BSM searches, as are gravitational wave searches and neutrino experiments.

Open problems and Conclusions

Overall, the program was highly successful in bringing together different communities of new physics hunters, thus laying the groundwork for novel, interdisciplinary, searches. The landscape of possible extensions of the Standard Model is vast, so the main remaining problem of the field is a lack of experimental or theoretical guidance – there is a huge number of well-motivated extensions of the Standard Model. A continued influx of data is therefore essential to guide theoretical efforts, with the most promising results expected from emerging fields like gravitational wave astronomy, new astrophysical and cosmological probes, new physics searches using atomic physics methods, neutrino physics, etc.