Cosmic messengers one-pager

Definition of cluster

The Cosmic Messengers cluster concerns Nikhef's long-term role in using non-collider messengers (gravitational waves, astrophysical neutrinos, ultra-high-energy cosmic rays and potentially gamma rays) to address fundamental questions about (dense) matter, gravity, astrophysical sources and the early universe.

This cluster is also connected to the construction and development of the Einstein Telescope (ET). While the detailed plans are covered by a dedicated gravitational-waves strategy, its long-term strategic direction should be addressed in the Nikhef-wide strategy. Furthermore, the cluster addresses the question of how such cosmic messenger programmes should be incorporated into Nikhef's broader scientific identity beyond 2040. It does not concern neutrino properties and precision measurements, which are part of the WIP cluster.

Note that all our current contributions regarding cosmic messengers, besides ET, will have their natural end by or around 2040.

Strategic questions

- How should Nikhef be involved in GW science after Virgo in the ET/LISA era?
- How do we get to an ET Roadmap proposal? This should be discussed in close collaboration with the gravitational-wave group.
- Should Nikhef follow an astronomy-style model (with instrumentation at Nikhef and data analysis mostly in university groups) or a particle-physics-style model (with the full chain integrated in Nikhef)? What is needed to achieve such an integrated model?
- To what degree should Nikhef engage in multimessenger astronomy and/or cosmology ? Which scientific questions would justify Nikhef involvement? Where is the boundary between Nikhef and ASTRON/SRON/NOVA in terms of topic coverage? Does this require national coordination?
- Where is Nikhef in the landscape of 2040+ observatories and successor experiments (e.g. SWGO, GRAND, HERON, CTA)?
- What technological capabilities should Nikhef prepare for now to be relevant in the 2040+ cosmic messenger landscape?

Which experts should be part of the cluster

- ET/GW instrumentation, science and analysis experts
- KM3NeT / UHECR representative (potentially shared person with cosmic messengers cluster)
- Detector technology representative
- Multimessenger / interpretation theorist

Outcome

- A desired Nikhef portfolio on Cosmic messengers in 2040: GW embedding and astrophysical particle observatories.
- Concrete scenarios on how to get there.
- A plan and timeline to arrive at a large-scale infrastructure (LSRI) roadmap proposal for ET.