RU-B

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A. Vision: What directions are essential to RU-B? What should we include or strengthen? What are the "big goals" for ORIGINS II in our field?

- (H.K.) **Dark matter searches at colliders** should get more weight in RU-B in the future program to complete the picture of dark matter searches, especially as there are cluster members involved in such searches.
- (S.M.) **Combine all ORIGINS neutrino mass probes:** KATRIN, LEGEND & cosmology. i) test of cosmological models, ii) a data-analysis projects applying unite methods (ODSL)
- (N.B.) **Studies of the nonequilibrium evolution of dark matter pairs** in the early universe aiming at obtaining a solid parameter space for each DM model.
- (N.B.) Studies of **quantum decoherence effects in neutrino physics**
- (M.B.) "**Quantum field theory in Cosmology**" and "**Gravitational Waves**“ / "Gravitational phenomen as probes of particle physics and vice versa”

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- (A.I.) pinning down the **nature of dark matter**: strengthen the interplay between particle physics and astrophysics for the search for dark matter
    - Direct detection of non-galactic light dark matter. poor knowledge of the DM envelope in the local group; dedicated simulations within ORIGINS
    - New constraints on the dark matter-neutrino and dark matter-photon scattering cross sections from TXS 0506+056. IceCube, MAGIC, models of CR acceleration in blazars, understand the DM distribution around black-holes, astrophysicists to model the neutrino/photon production in blazars, people in IceCube/MAGIC/CTA to look for sources, and particle physicists to understand the implications for DM models.
    - Complementarity of experiments in probing the non-relativistic effective theory of dark matter-nucleon interactions. Discussion with CRESST and IceCube

A. Vision: “local projects”

- (P.F.) Electrostatic storage ring (financed through ORIGINS I): for future EDM searches, Dark Matter/Dark Photons. **Under construction.** Possible future application: short distance gravity with charged micro or nano particles
- (P.F.) Extreme zero magnetic field labor: Xe-129 EDM
- (S.M.) ComPol part of LRSM

A. Vision: “international projects” with ORIGINS scientists leadership/initiated/key roles

- **Majorana nu’s & LN violation:** (co-)initiated from TUM; LEGEND-1000 is front runner experiment in European/North-American selection process (ERC-adv StS; co-spokesperson); Start of LEGEND-200 end of 2022
- **Neutrino astrophysics:** P-ONE explorer phase financed through ORIGINS (ERC-adv ER, spokesperson) and IceCube
- **Neutrino coherent scattering:** NUCLEUS (ERC-starting RS, spokesperson)
- **Direct DM:** CRESST (FP, spokesperson)
- **Neutrino mass**: KATRIN with the extension of TRISTAN to search for keV-scale sterile neutrinos (ERC-starting SM, co-spokesperson)

Capitalize on projects with clear international leadership and visibility by ORIGINS-II – consider strategic investments

“Noble prize class of experiments”

B. (incomplete) list of ORIGINS research highlight (after 2018)

- E.R.: Evidence for neutrino emission from the nearby galaxy NGC1068, IceCube Collaboration, **Science** (in print 2022)
- L.F.: Measurement of antihelium-3 nuclei absorption in matter and impact on their propagation in the galaxy“, ALICE Collaboration, **Nature** (2022)
- S.M.: New Constraint on the Local Relic Neutrino Background Overdensity with the First KATRIN Data Runs, Katrin Collaboration, PRL129, 011806 (2022)
- S.M.: Direct neutrino-mass measurement with sub-eV sensitivity, Katrin Collaboration, **Nature Physics** 18, 160–166 (2022)
- A.I: Direct detection of non-galactic light dark matter Phys.Lett.B 820 (2021) 136551
- St.S./L.O.: Experimental evidence of neutrinos produced in the CNO fusion cycle in the Sun, **Nature** 587, 577–582 (2020)
- St.S.: Probing Majorana neutrinos with double-β decay, **Science** 365, 1445 (2019)
- F.P. / St.S: First results from the CRESST-III low-mass dark matter program, **Phys.Rev.D** 100 (2019) 10, 102002
- E. R.: Neutrino emission from the direction of the blazar TXS 0506+056, **Science** 361, 147-151 (2018)
- N. Brambilla et al. Transport coefficients from in medium quarkonium dynamics e-Print: 1903.08063 52 citations; gives an idea of EFT/open quantum system techniques that we will be using in DM and Heavy Majorana neutrino studies.
- M.B. et al.: Collinear and soft gravitational physics (2110.02969, 2112.04983)

Extra slides