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Probing the Electroweak Phase Transition with Colliders and Gravitational Waves (15' + 5')

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Symmetries that are broken at zero temperature will typically be restored as the temperature is raised. A familiar example is the alignment of spins in a ferromagnet. Symmetry restoration may be accomplished by either a smooth crossover or a first order phase transition, i.e. bubble nucleation. In the Standard Model of particle physics, we are interested in the nature of the electroweak phase transition during which the Higgs condensate formed and the weak gauge bosons became massive.

If the electroweak phase transition was first order, the collision of Higgs-phase bubbles would have generated a stochastic background of gravitational waves. I will discuss the prospects for directly detecting this signal with gravitational wave interferometry. Additionally, new particles and interactions are required in order for the phase transition to be first order. I will discuss what signals of this new physics might be seen at the LHC or future colliders.

Since the 1960's, the capture of relic neutrinos on tritium has been explored as a detection strategy, and recent advances in detector technology may finally bring a measurement within reach. A direct detection of the relic neutrinos has the potential to probe a number of fundamental neutrino properties including the Dirac / Majorana distinction, the absolute mass scale, and neutrino lifetime. Since the relic neutrinos are non-relativistic today, their direct detection would provide the first measurement of neutrinos in this kinematic regime.

In principle, the same detection strategy could be used to probe keV sterile neutrino dark matter. In the talk, I will discuss the prospects and challenges for such a measurement.

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