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Testing gravitational theories with broken Lorentz symmetry by gravitational wave observations

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Lorentz symmetry is the cornerstone of modern physics, and is consistent with all experiments carried out so far. However, due to various motivations, gravitational theories with Lorentz symmetry breaking have been proposed, and one of the examples is the Horava-Lifshitz theory, motivated by the quantization of gravity. Another example is the Einstein-aether (æ-) theory, which is a vector-tensor theory with the vector (aether) field being always timelike and unity. The æ-theory is self-consistent (such as free of ghosts and instability), and satisfies all the experimental tests carried out so far. Its Cauchy problem is well-posed, and energy is always positive (at least as far as the hypersurface-orthogonal aether field is concerned). In addition, black holes exist and can be formed from gravitational collapse of realistic matter.

In this talk, we shall present our recent studies of gravitational waves (GWs) produced by massive and compact objects in æ-theory, including their waveforms, polarizations, response function, its Fourier transform, and energy loss rate through three different channels of radiation, the scalar, vector and tensor modes. Combination of such theoretical predictions with observations of GWs can bring severe constraints on the theory.

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