



Contribution ID: 33

Type: **Talk**

# Causality and Stability from the Acoustic Metric

Scalar-tensor theories with derivative interactions form backgrounds which spontaneously break Lorentz invariance (cosmology during inflation or the dark energy era is the archetype). I will discuss how to think about the dynamics of free scalar perturbations, phonons, on general anisotropic backgrounds, showing that phonons move on null geodesics of an acoustic spacetime described by its own metric and own connection. This acoustic metric and its inverse give the dispersion relation, rays and phase velocities and construct two sound cones. The acoustic connection features non-metricity with respect to the usual spacetime.

I will discuss how to read off true instabilities, ghosts and gradient instabilities, from the invariant properties of the acoustic metric, but also discuss false instabilities that may appear for some observers, relating this to Cherenkov radiation and the ill-posedness of the Cauchy problem.

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**Track Classification:** Contributed talks