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Gravitational waves from hot and cold hidden sectors

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We study the spectrum of gravitational waves produced by a first order phase transition in a hidden sector that is colder than the visible sector. In this scenario, bubbles of the hidden sector vacuum can be nucleated through either thermal fluctuations or quantum tunnelling. If a cold hidden sector undergoes a thermally induced transition, the amplitude of the gravitational wave signal produced will be suppressed and its peak frequency shifted compared to if the hidden and visible sector temperatures were equal. This could lead to signals in a frequency range that would otherwise be ruled out by constraints from big bang nucleosynthesis. Alternatively, a sufficiently cold hidden sector could fail to undergo a thermal transition and subsequently transition through the nucleation of bubbles by quantum tunnelling. In this case the bubble walls might accelerate with completely negligible friction. The resulting gravitational wave spectrum has a characteristic frequency dependence, which may allow such cold hidden sectors to be distinguished from models in which the hidden and visible sector temperatures are similar. We compare our results to the sensitivity of the future gravitational wave experimental programme.

Presenter: WICKENS, Alastair (King's College London)

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