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## Gravitational Redshifts in Clusters of Galaxies

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Wojtak, Hansen and Hjorth (Nature, 2011) have measured the long-predicted gravitational redshifts in galaxy clusters using Sloan Digital Sky Survey data. The effect is very small, corresponding to a velocity shift of only  $\sim 10$  km/s in clusters with internal random motions  $\sim 600$  km/s) but is in good agreement with general relativity predictions and possibly in conflict with some alternative gravity theories. Zhao, Peacock and Li (2012) showed there should also be a competing special relativistic effect - the transverse Doppler (TD) effect - of similar magnitude. In this talk I will describe how there are two more kinematic effects that need to be considered in interpreting these observations; a 'light cone' effect that augments the TD shift and a competing effect caused by modulation of the surface brightness of galaxies by relativistic beaming. I will discuss how these observations constrain gravitation theory.

**Primary author:** Dr KAISER, Nicholas (Institute for Astronomy, U. Hawaii)

**Presenter:** Dr KAISER, Nicholas (Institute for Astronomy, U. Hawaii)

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