



# X-RAY ASTRONOMY 2019

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## Tension with the $\Lambda$ CDM model from a Hubble diagram of quasars.

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The cosmological concordance model ( $\Lambda$ CDM) well accounts for a wealth of observations, from the existence of Cosmic Microwave background (CMB) to the discovery of the accelerated expansion of the universe from Type Ia supernovae. Yet, it assumes a still unknown form of dark energy and matter and some tensions arose recently as, for instance, the discovery of a  $>3\sigma$  discrepancy between the local (Riess et al. 2016) and Planck (Aghanim et al. 2016) measurement of  $H_0$ . In addition, the  $\Lambda$ CDM model is poorly tested in the redshift interval between the farthest observed Type Ia supernovae ( $z \sim 1.4$ ) and that of the CMB ( $z \sim 1100$ ). We present new measurements of the expansion rate of the Universe in the redshift range  $z=0.5-5.5$  based on a Hubble diagram of quasars. The distance of quasars have been estimated from the observed non-linear relation between the X-ray and ultraviolet emission, following a method developed by our group. The distance-redshift relation of quasars at  $z < 1.4$  is in agreement with that of supernovae and with the concordance model. Nonetheless, a deviation from the  $\Lambda$ CDM model emerges at higher redshift, with a statistical significance of  $\sim 4\sigma$ . We found that, if an evolution of the dark energy equation of state is allowed, our data suggest a dark energy density increasing with time.

### Topic

### Affiliation

Dipartimento di Fisica e Astronomia, Università di Firenze

**Primary author:** LUSSO, Elisabeta (Dipartimento di Fisica e Astronomia, Università di Firenze)

**Presenter:** LUSSO, Elisabeta (Dipartimento di Fisica e Astronomia, Università di Firenze)

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