Tracing The Expanding Universe with Quasars

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First discovered at the end of the 90's by measuring the distances of exploding stars, supernovae, dark energy is a new and still unknown type of energy that makes the expansion of the Universe accelerate. The presence of dark energy has been also confirmed by the cosmic microwave background (CMB), the first light in the Universe history dating back to 360 million years after the Big Bang.

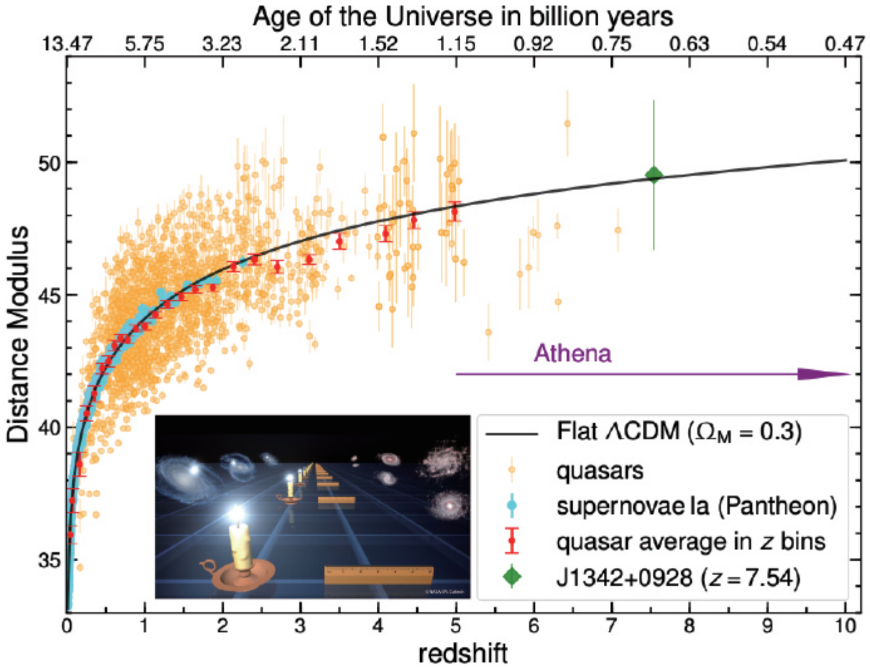
Whilst supernovae can explore the behaviour of dark energy during the last 10 billion years, very little is known about the expansion of the early Universe in the epoch between the farthest observed supernova and the CMB.

Recently, another kind of astrophysical object has been added to the list of cosmic tracers to sustain the effort to understand the dark energy: quasars. Quasars are accreting black holes located in the centre of galaxies, billions of times more massive than the Sun. Quasars shine bright across the entire electromagnetic spectrum, from optical to X-rays. With luminosities about 100-1000 times larger than that of the host galaxy, they can be observed up to huge distances from the Earth.

Quasars can thus be the bridge between the most distant supernova and the CMB, measuring the expansion rate of the Universe up to z~7.5, the highest quasar redshift observed so far, when the cosmos was only 700 million years old. Yet, present-day X-ray facilities have detected only a few tens of very bright quasars at z>5, which is not sufficient to make significant progress in understanding the early evolution of the Universe. For quasars to become optimal cosmological probes, it is necessary to observe several hundreds of objects, which is beyond the capabilities of current X-ray telescopes.

Athena will profoundly change the game with its unrivalled sensitivity and wide field of view, uncovering the bulk of the quasar population at z>5 over a much wider range of luminosities than that accessible to XMM-*Newton* and *Chandra*. *Athena* will reveal quasars at unprecedented distances, z~8-10, placing key constraints on the expansion rate of the young Universe.

The accuracy in the determination of quasar X-ray fluxes achieved by *Athena* will be vital to test the state-of-the-art cosmological models. *Athena* will provide deeper insights into the nature of dark energy and its possible evolution across cosmic time.



Hubble diagram (i.e. the distance modulus - redshift relation) of quasars (gold points) and supernovae (cyan points). Red points are averages of quasars' distance moduli in narrow redshift bins. The black line represents the standard flat concordance model with a reference value of dark energy $\Omega_\Lambda=1-\Omega_M$. The green diamond marks the value for the most distant quasar ever observed. Athena will unveil quasars at unprecedented distances, z~8-10, placing essential constraints on the expansion rate of the young Universe. Credits: G. Risaliti & E. Lusso. The inset illustrates how sources with known brightness can be used to estimate their distances and the expansion of the Universe. Credits: NASA/JPL-Caltech.

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