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Searching for cosmological spatial variations in values of fundamental constants using laboratory measurements

The results of a very large study of around 300 quasar absorption systems using data from both the Keck telescope and the Very Large Telescope provide hints that there is a spatial gradient in the variation of the fine structure constant, alpha. In one direction on the sky alpha appears to have been smaller in the past, while in the other direction it appears to have been larger. A remarkable result such as this must be independently confirmed by complementary searches.

Terrestrial measurements of time-variation of the fundamental constants in the laboratory, meteorite data, and analysis of the Oklo nuclear reactor can be used to corroborate the spatial variation observed by astronomers. In particular we can expect laboratory measurements to show an annual variation in alpha at parts in 10^(19). The required accuracy is two orders of magnitude below current atomic clock limits, but there are several proposals that could enable experiments to reach it. These include nuclear clocks and transitions in highly-charged ions that would have the highest sensitivity to variation of the fine-structure constant ever seen in atomic systems.

Primary authors: Dr BERENGUT, Julian (University Of New South Wales); Prof. FLAMBAUM, Victor (University Of New South Wales)

Presenter: Dr BERENGUT, Julian (University Of New South Wales)