Study shows a sharp rise in detection rate of broad absorption line variations

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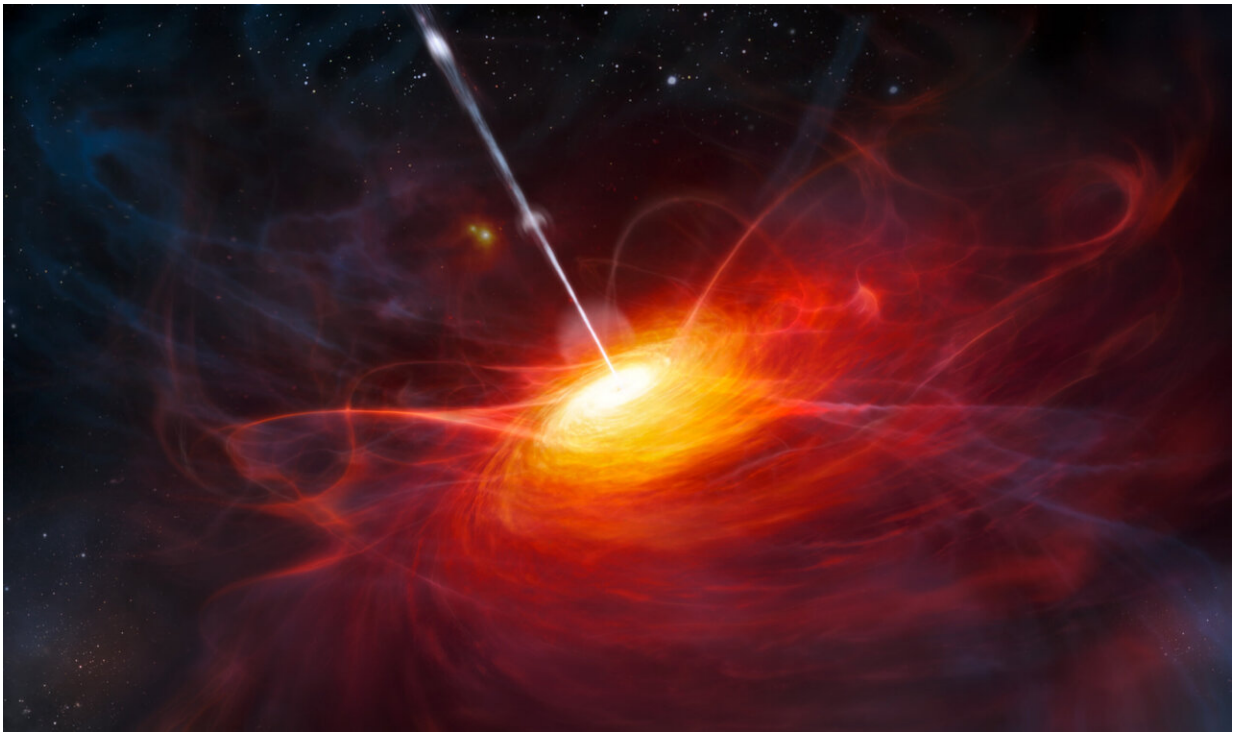

Artist's rendering of the accretion disk in ULAS J1120+0641, a very distant quasar powered by a supermassive black hole with a mass two billion times that of the Sun. Credit: ESO/M. Kornmesser

Gas around black holes and interstellar medium distribution are key factors in understanding the growth of supermassive black holes and the evolution of their host galaxies. However, as a crucial parameter, gas

density is hard to determine reliably, because the general method is not applicable to all quasars.

Researchers from the University of Science and Technology of China (USTC) of the Chinese Academy of Sciences (CAS) for the first time detected a 'sharp rise' signature in the detection rate of broad absorption line (BAL) variations, which in turn deduced ionized gas density. The work was published in *The Astrophysical Journal Letters* on January 11, 2021.

The ionization state of a gaseous outflow requires a period of time (recombination timescale, trec) to respond to changes in the ionizing continuum for the ionized outflows. Trec is inversely proportional to the gas density.

Accordingly, a previous study reported by the group of Prof. Wang Tinggui and Prof. Liu Guilin from USTC of CAS proposed that the gas density can be determined by measuring trec.

They assumed the probability of detecting the variability of a BAL with trec at observational time interval (ΔT) is a step function. In other words, the BAL variability can be detected when the trec is shorter than the ΔT.

Following the same method, sharp rise phenomena are present in the detection rate of several different BALs in the quasar SDSS J141955.26+522741.1 from the Sloan Digital Sky Survey Data Release 16 (SDSS DR16), which indicates that this measuring method is reliable.

Researchers first found that the detection rate curve could be used to distinguish gaseous components with different density but the same velocity and location, optimizing the group's work on the new method measuring gas density by trec.

More information: Qinyuan Zhao et al. A Sharp Rise in the Detection Rate of Broad Absorption Line Variations in a Quasar SDSS J141955.26+522741.1, *The Astrophysical Journal* (2021). DOI: 10.3847/2041-8213/abd318