USTC astronomers have measured the sizes of ～1 000 quasar outflows

Under the support of the National Natural Science Foundation of China, the research team led by Prof. Wang TingGui (王挺贵) and Prof. Liu GuiLin (刘桂琳) at the CAS Key Laboratory for Research in Galaxies and Cosmology, Department of Astronomy, University of Science and Technology of China (USTC), recently reported their novel method to measure the spatial scale of quasar outflows, which has led to the first determination of the distribution of ionized gas properties surrounding the active super-massive black holes that reside in galaxy centers. Their journal paper has been published in *Nature Astronomy*, and is accessible through the following link: https://doi.org/10.1038/s41550-018-0669-8

Active galactic nuclei often drive powerful outflows that carry a significant amount of gas and energy, producing strong effects on the surrounding environment, and have long been considered a potential key factor in regulating the growth of super-massive black holes and the evolution of their host galaxies. Due to the complexity of outflows and the limit of current facilties, people have little knowledge of the physical properties of outflows and their influences on galaxy evolution.

How does a galaxy and the super-massive black hole in its center co-evolve in the cosmic history? This is one of the key questions that astronomers have been struggling to tackle. Modern galaxy formation and evolution models postulate that an active black hole drives powerful outflowing gas that produces strong effect on the surroundings, which plays a key role in regulating this co-evolution. The validation of this scenario hinges on efficient measurements of a number of key parameters of the outflow, one of which is the distance of the outflowing gas from the central black hole (the so-called "outflow radius").

Nevertheless, measuring the outflow radius turns out to be highly challenging, especially for the most energetic outflows that often manifest themselves as broad absorption lines in a quasar's spectrum. Due to various limitations, conventional approaches have only made it possible to measure the radii of dozens of individual outflows over the past couple of decades. From the new perspective of bridging the variability of these absorption line features with the outflow radii, this research group at USTC has successfully depicted the statistical distribution of the outflows' physical properties through studying the variability of the CIV broad absorption line in a sample of nearly a thousand quasars from the Sloan Digital Sky Surveys. As a result, these outflows are found to be have a typical radius of tens of parsecs, and their typical mass flow rates and energetics are in line with the expectation that outflows often exert a strong "feedback" effect on their host galaxies. These results pose a strong and direct constraint on galaxy evolution models, and will help deepen our understanding of the evolution of all galaxies in the cosmic history.

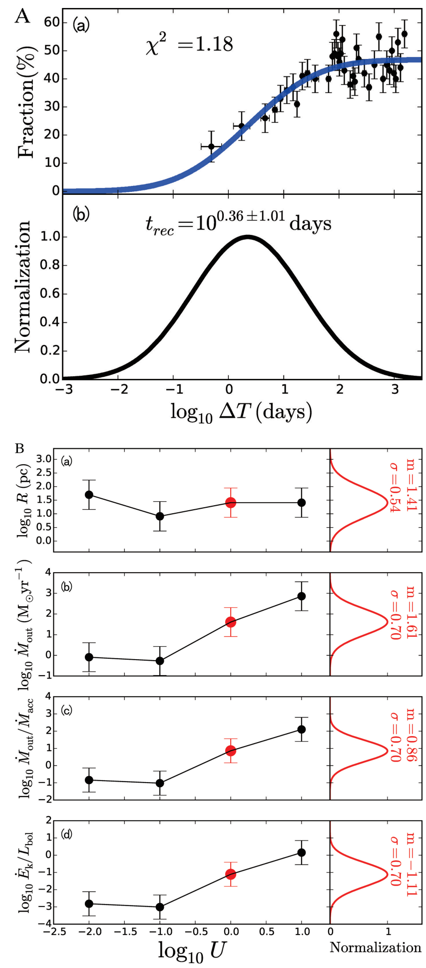

Figure A: the fraction curve of BAL variabilities and the inferred recombination timescales distribution in the SDSS sample. B: distributions of the properties of the BAL outflows at different ionizing parameters.