Searching the Predecessor of the Merging Galaxy

On a clear night in 1785, William Herschel used his own telescope to observe as usual. The difference is that this night he found a very unusual celestial object in Corvus (the Antennae Galaxy, Figure 1). Since then, such kind of celestial objects, called the merging galaxies, have fascinated countless astronomers. How is it formed? How does it evolve? These questions are hot topics in astronomy today.

Nowadays, more than 200 years later, scientists have been able to reproduce the formation process of the merging galaxies with numerical simulations. Because of the gravitational attraction, two galaxies would first approach each other, which are observed as a galaxy pair in this phase. Then, the violent collision process leads to dramatic changes on the shapes of the galaxies, thus forming special structures that are significantly different from normal galaxies (see Figure 2 for an illustration).

Recently, a research team from the Shanghai Astronomical Observatory (SHAO), Chinese Academy of Sciences (CAS) published a new research result on galaxy pairs in the *Astrophysical Journal*. In this study, they first constructed the largest galaxy pair sample to date, and then accurately measured the bivariate luminosity function of galaxy pairs. "The bivariate luminosity function tells us a whole story on what is the probability of a galaxy that could be paired with another galaxy at given luminosities, and also gives us hints on how often galaxy merging events occur in the nearby universe," said Prof. SHEN Shiyin, the corresponding author of this work.

As shown by the numerical simulation, the merging timescale of two galaxies is up to one to two Giga years. Thus, the overall process of galaxy merging event could not be fully observed by human beings. Using the bivariate luminosity function of galaxy pairs as a statistical approach, this work probably has found the first observational evidence on the galaxy merging timescale. "The global timescale from two gravitational bounded galaxies to final merging depends on the

Figure 1: Antennae Galaxy. This merging galaxy was first discovered by William Herschel. (Credit: Hubble Space Telescope, NASA)

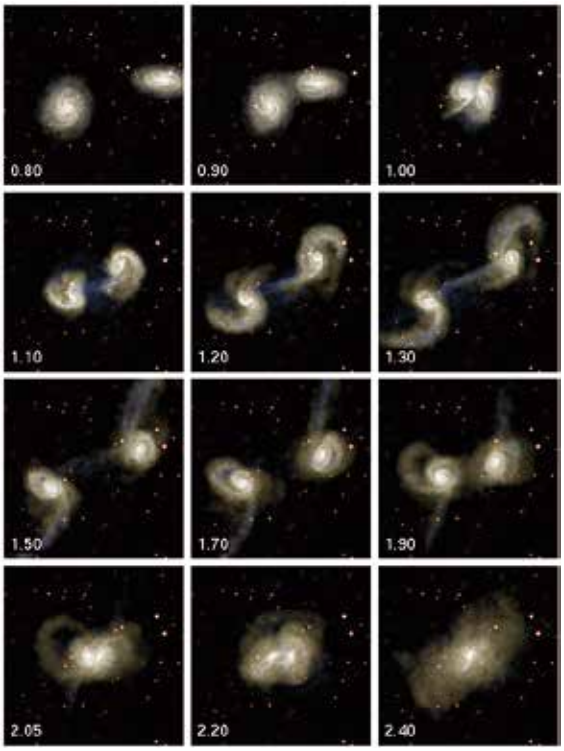

Figure 2: Galaxy merging process from numerical simulation. The time (in billions of years since the beginning of the simulation) is indicated by the number in each picture. (Credit: Max-Planck Institute of Astrophysics)

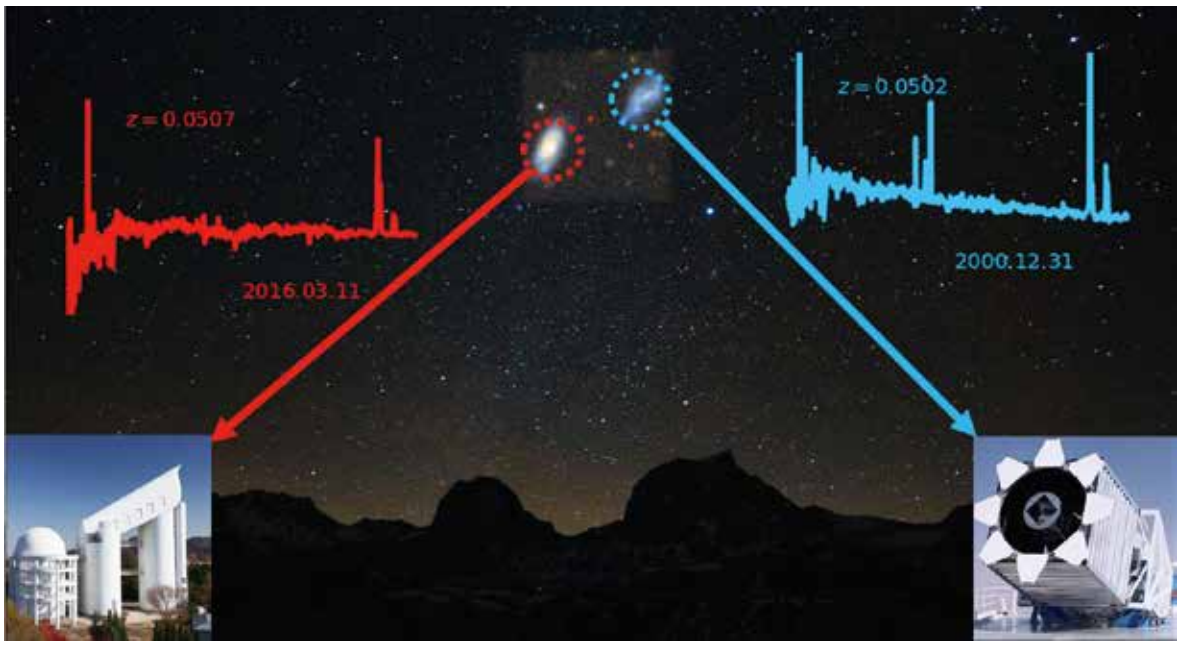

Figure 3: An example of the spectroscopic observation of a galaxy pair. The spectroscopic observations of two very close galaxies were completed by the Sloan Digital Sky Survey (blue) and the LAMOST spectral survey (red) respectively. Only by obtaining the spectroscopic distances of the two galaxies can we finally identify whether they are a genuine pair or an illusion accidentally caused by projection effect. (Credit: SHAO)

mass configuration of two galaxies," FENG Shuai, first author of this study further explained. FENG is a Ph.D student supervised by Prof. SHEN Shiyin. "Typically, two massive galaxies with equal mass merge most quickly."

In this work, besides the public astronomical database, the LAMOST (Large Sky Area Multi-object Fiber Spectroscopic Telescope) located in Xinglong Station of the National Astronomical Observatory of Chinese Academy of Sciences (NAOC) has made a significant contribution. For two very close galaxies on the sky like a galaxy pair, a regular multi-fiber spectroscopic survey (like Sloan Digital Sky Survey, also known as SDSS) typically can only target one of the members due to fiber collisions. One of the important observational samples of the LAMOST spectral survey is to supplement the missed main sample galaxies in the SDSS. The combination of the two surveys constitutes the largest sample of spectroscopic identified galaxy pairs so far, thus providing the foundation for this innovative statistical study.

Online link to the paper: https://iopscience.iop.org/article/10.3847/1538-4357/ab24da

(SHAO)