New evidence on the merging history of the Milky Way

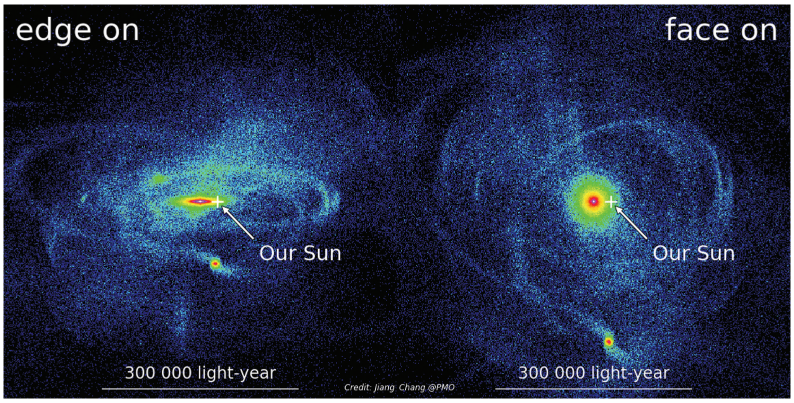
Supported by the National Natural Science Foundation of China, the research team led by Prof. Zhao Gang (赵刚) at the National Astronomical Observatories, Chinese Academy of Sciences, discovered new evidence on the merging history of the Milky Way in both kinematic and chemical space by using LAMOST spectra. A series of new results have been published in famous international astronomical journals, including the *Astrophysical Journal*.

The research team has detected seven new moving groups in kinematic space, which covers 50% of the total number of such groups found so far. In chemical space, they found 33 so-called low-alpha stars that are different from normal alpha-enhanced halo stars in the Galactic field. Both moving groups and low-alpha stars are thought to be remnants of disrupted dwarf galaxies forming our Milky Way.

A stellar stream, named from its stream-like morphology, is an association of stars with common origin and thus has intrinsic features. Stellar streams appear as spatial over-densities in the beginning. After several hundred million years' evolution, they are torn apart and stretched out by the tidal force. Therefore, many stellar streams, which entered into our Milky Way a long time ago, do not show spatially coherent structures, which makes the detection very difficult. The seven new moving groups and 33 low-alpha stars detected by Zhao's team belong to this kind of indistinct stellar stream. The referee of the *Astrophysical Journal* appraised, "The authors provide some insights in terms of chemical evolution of the Galaxy, and how their results corroborate with the currently accepted scenarios. The early results from LAMOST shown in the paper are an important milestone in this project."

Based on these new findings, Prof. Zhao and his colleagues propose a three-stage evolution sequence for stellar streams, named the early, middle and late stages, corresponding to three kinds of morphology. Stellar streams in the early stage preserve coherent structures in physical space and can be recognized easily. In the middle stage, stream members may still keep structures in kinematics, but spread widely and become unrelated in space. So the difficulty of detection is increased significantly. The most difficult case is the detection of stellar streams in the late stage when their members completely lose structures in both space and kinematics. The only solution is to search for the chemical imprints via careful analysis of their spectra.

Zhao's team has developed a method to detect late-stage stellar streams. "This method is like a DNA paternity test," Prof. Zhao said, "We use the chemical DNA of the stars to find their parents." Stellar streams in the middle and late stages are of high importance in understanding the galaxy formation and exploring the Galactic potential and its mass distribution.



The new discoveries of Zhao's team have greatly enhanced the efficiency of stellar stream detection and show great advantages and potential of LAMOST spectroscopic survey in the study of the Milky Way. It can be expected that more stellar streams will be detected in the near future by a combination of LAMOST with Gaia in hope for revealing the mystery of the Milky Way.