ELSEVIER

CrossMark

Chinese Astronomy and Astrophysics 42 (2018) 1–19

CHINESE
ASTRONOMY
AND ASTROPHYSICS

# Research Progresses of Halo Streams in the Solar Neighborhood† ⋆

LIANG Xi-long[1,2] ZHAO Jing-kun[1△] CHEN Yu-qin[1] ZHAO Gang[1,2]

[1] *Key Laboratory of Optical Astronomy, National Astronomical Observatories, Chinese Academy of Sciences, Beijing 100012*

[2] *School of Astronomy and Space Science, University of Chinese Academy of Sciences, Beijing 100049*

**Abstract** The stellar streams originated from the Galactic halo may be detected when they pass by the solar neighborhood, and they still keep some information at their birth times. Thus, the investigation of halo streams in the solar neighborhood is very important for understanding the formation and evolution of our Galaxy. In this paper, the researches of halo streams in the solar neighborhood are briefly reviewed. We have introduced the methods how to detect the halo streams and identify their member stars, summarized the progresses in the observation of member stars of halo streams and in the study of their origins, introduced in detail how to analyze the origins of halo streams in the solar neighborhood by means of numerical simulation and chemical abundance, and finally discussed the prospects of the LAMOST and GAIA in the research of halo streams in the solar neighborhood.

**Key words** Stars: stellar streams—Stars: halo streams—Stars: abundances

## 1. INTRODUCTION

The study on the galactic formation and evolution is one of the most important frontier fields in modern astrophysics. According to the cosmological model of Λ cold and dark matter (ΛCDM), there are mergers everywhere, and some trails should be remained reasonably in galaxies like the Milky Way[1,2]. During the merging process, the Milky Way has accreted

† Supported by National Natural Science Foundation (U1431106, 11390371, 11625313, 11233004)973 Project (2014CB845701/03)

Received 2016–10–08; revised version 2016–11–28

⋆ A translation of *Progress in Astronomy* Vol. 35, No. 2, pp. 175–189, 2017

△ zjk@bao.ac.cn


doi:10.1016/j.chinastron.2018.01.001

and merged many external (dwarf) galaxies and star clusters, which are disrupted into stellar streams by the tidal interaction. However, through the evolution in several billions of years, it is difficult to detect the evidently clustered stellar streams in the position space of the solar neighborhood[3]. A stellar stream means a group of stars with a common kinematic feature, and it is named by the distribution as like a long strip of water flow in space. The member stars of a stellar stream are originated from a common parent source, in the parametric space (position, speed, and elemental abundance) they exhibit the common features different from those of the original galactic field stars. Stellar streams have mainly two origins: one is the dynamic stream caused by the galactic bar or spiral arm; and another one is the tidal debris, which comes from the satellite galaxies accreted by larger galaxies, or the globular clusters disrupted and pulled out from their orbits by the tidal force. This paper discusses mainly the tidal streams from the Galactic halo when they pass by the solar neighborhood.

With the continuous development in both observation and theory, the study on the formation mechanism of our Galaxy becomes deeper and deeper. In 1962, Eggen et al. found a correlation between the orbital eccentricities and metal abundances of stars in the solar neighborhood, and proposed the model of fast collapse for the formation of Milky Way[4]. They suggested that the Milky Way is formed by the gravitational collapse of a nearly spherical and huge protogalactic cloud. In 1978, Searle and Zinn found that there is no gradient of metal abundance in the globular clusters located in the outer Galactic halo, but there is a dispersion in the age[5], thus it is proposed that the Milky Way is formed by a slow and chaotic process: by gradually merging and accreting the independent mass debris, it gradually grows up from small to large to form an image. In 2000, Chiba and Beers found that the density distribution of the Galactic halo is gradually changed from a relatively flat distribution in the interior to a spherical distribution in the exterior, and there is a continuous inverse-rotational component above the disk, which can not be explained by the configuration of formation from small to large[6]. Afterwards, the galactic version of cosmological "merging tree" appeared (image of hierarchical formation)[7−12].

In this paper, Chapter 2 introduces the detection of stellar streams in the solar neighborhood, and describes in detail how to identify a stellar stream in the solar neighborhood; Chapter 3 introduces how to study the stellar streams by means of numerical simulation and chemical composition, to determine some properties of stellar streams by analyzing the element abundance, and further to make some conjectures for the progenitors of halo streams, in addition, the new possibility that the halo streams are originated from an unsymmetrical potential is also briefly mentioned; and Chapter 4 makes a simple summary and prospect.

## 2. DETECTION OF HALO STREAMS IN THE SOLAR NEIGHBORHOOD

In 1999, Helmi et al.[1] first defined the members of a halo stream in the solar neighborhood in terms of probability. When the halo streams are searched from a large sample of data, people pay attention to detecting statistically the halo streams, rather than to identify practically