Torus-Fitting Method in Two-Dimensional Galactic Potentials

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A new method called a torus-fitting method (hereafter TF method), by which a generating function is derived numerically for models of the Galactic potential in which almost all orbits are regular is proposed. We found that the TF method can be applied to major orbit families (box and loop orbits) in some two-dimensional potentials. Furthermore, the TF method is still applicable to resonant orbit families. Hence, the TF method is useful for analysing real Galactic systems in which a lot of resonant orbit families might exist [1].

The surface of section (x, px) with y = 0 in the logarithmic potential with q = 0.9 and Rc = 0.14 is shown in Fig. 1. The solid curves represent the target tori derived by the direct calculation of the orbits of five test particles. The plus symbols show the reconstructed target tori by use of the TF method. We find that the reconstructed tori correspond very well to the tori derived directly from the orbits. It proves that the TF method works very well for major orbits. Furthermore, the square symbols represent the target tori derived by the TF method in which the generating functions are estimated by the interpolation technique. The interpolation also works very well for major orbits.

We aply this mehod also for minor orbits. The brief procedure for the minor orbit is as follows. Illustration of the resonant torus and the additional curve is shown at left in Fig. 2. The resonant torus can be reconstructed by the two pseudotori. One of the pseudo-tori consists of the additional curve (except for the additional curve inside the resonant tours) and the upper part of the resonant torus as shown at upper right. Another one consists of the additional curve (except the additional curve inside the resonant tours) and the lower part of the resonant torus as shown at lower right. We can reconstruct the minor orbit using these two pseudo-tori.

The surface of section (x, px) with y = 0 in the logarithmic potential with q = 0.6 and Rc = 0.14 is shown in Fig. 3. The solid lines represent the target tori derived by the numerical calculation of the orbits of test particles. The plus symbols show the reconstructed target tori containing resonant tori reconstructed using the above procedure. This shows that the TF method works very well also for minor orbits.

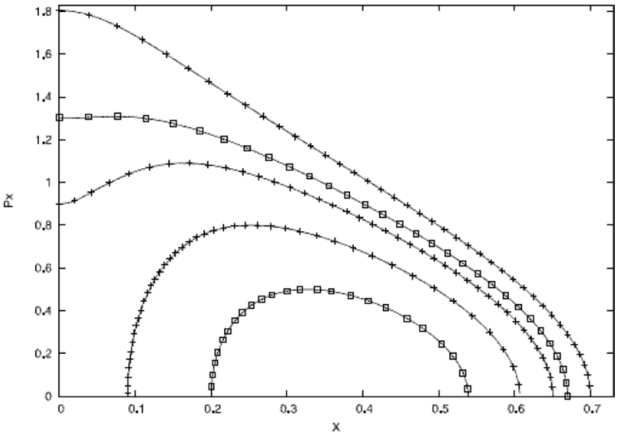

Figure 1: The surface of section (x, px) with y = 0 in the logarithmic potential. Solid lines represent the target tori derived by the numerical calculations. The plus symbols show the reconstructed target tori. The square symbols represent the target tori using the interpolation technique.

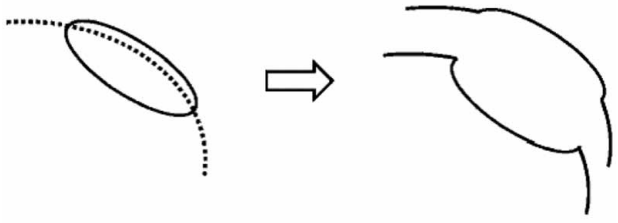

Figure 2: Method to aply for the minor orbit.

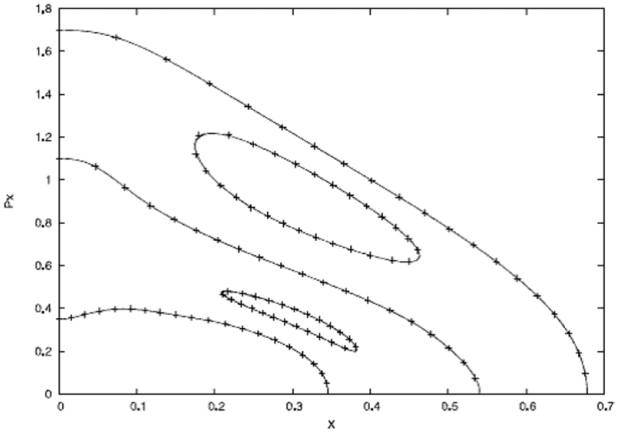

Figure 3: Application of the torus fitting method to the minor orbit.

Reference

[1] Ueda, H., Hara, T., Gouda, N., Yano, T.: 2014, *MNRAS*, **444**, 2218.