StreamTeam TNG: In The Arms of The Galactic Bar- Exploring The Fate of Stellar Streams

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Overview

Stellar streams are groups of stars from globular clusters or dwarf galaxies that have been stretched out, along their orbits, by tidal forces. Peculiar features of some streams,eg: fanning and truncation, have been proposed to have been caused by interaction of these streams with the galactic bar. For instance, the truncation of the leading arm of the Palomar 5 stream[1] and the interestingly short length of Ophiuchus stream[2] have all been linked to their interaction with the galactic bar.

In our study, we sought to answer the question: what can up-to-date N-body simulation codes tell us about how the bar affects stream formation? To do so, we took two steps in our approach:

1. Modelling orbits
2. Modeling streams

Step 1- Modelling orbits

First, we used the Gala[3] Python package to model a Milky Way Potential with a rotating bar.

Our model of the Milky Way (MW) potential is a four-component composite potential made of a disk[4], halo[5], bulge and a bar[6] with pattern speed of 42 kms^{-1} kpc^{-1}. We verified our rotating frame with a simulation of the sun's orbit both at corotation and in a static reference frame and also checked for conservation of Jacobi Energy.

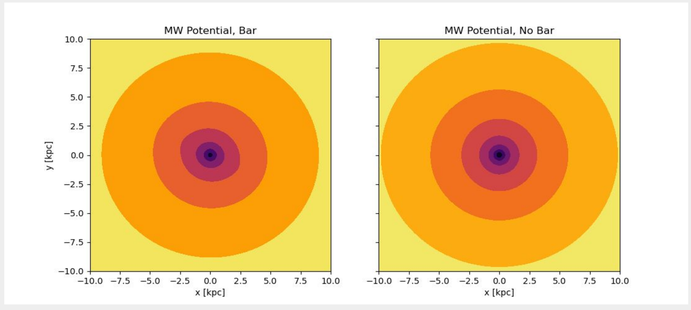

Figure 1. Density contours for MW potential with rotating bar (left) and MW potential without rotating bar (right) in Galactocentric coordinates.

Finally, from all the streams in the Galstreams library[8], we selected six streams whose orbits have pericenter less than or equal to 8 kpc and in prograde motion to the bar[1]. We used the Gala[3] Python package to simulate their orbits in both the bar and no bar potentials.

Streams	Pericenter in kpc (Bar Potential)	Ranks	Pericenters in kpc (No Bar Potential)	Ranks
Hrid	0.83	1	1.17	1
Palomar 5	6.56	6	6.79	6
Ophiuchus	4.12	4	4.04	4
Svol	4.94	5	4.82	5
M2	1.07	2	1.55	3
M92	1.39	3	1.42	2

Figure 2. Selected streams and their orbit pericenters ranked from smallest(1) to largest(6) in both bar and no bar potentials.

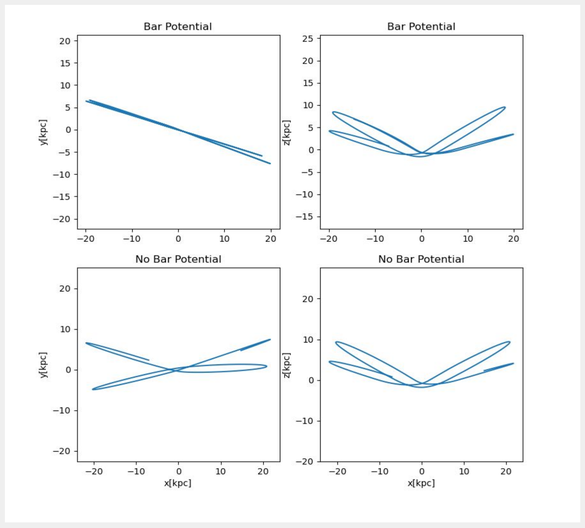

Figure 3. Orbit of Hrid in bar potential (top panel) and no bar potential (bottom panel) in a static reference frame using Galactocentric coordinates

Step 2- Modelling streams

We used the Gala[7] Python package to generate mock stellar streams of our selected streams in both the bar potential and the no bar potential to observe morphological differences, if any.

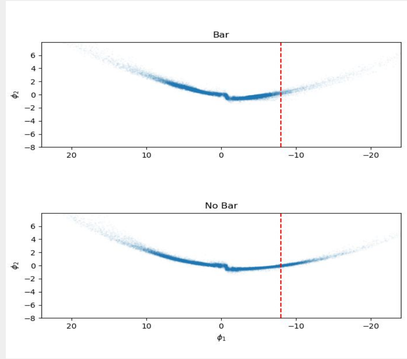

Figure 3. Palomar 5 in bar potential (top panel) and no bar potential (bottom panel) in stream coordinates $\phi 1$ (along the stream) and $\phi 2$ (perpendicular to the stream).

Red dashed lines show truncation of leading arm at ~ 8°as observed in PAN-STARRS 1 data[1].

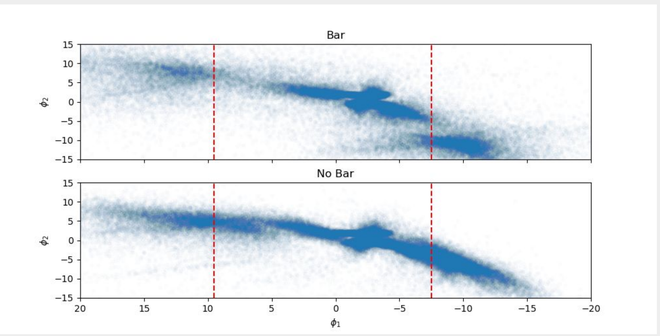

Figure 4. Mock stream of M92 in the bar potential (top panel) and no bar potential (bottom panel) in stream coordinates $\phi 1$ (along the stream) and $\phi 2$ (perpendicular to the stream).

Conclusions

1. The truncation of the leading arm of the Palomar 5 mock stream seen in the bar potential confirms that method of modelling streams well as a way to perform our analysis.
2. Mock stream shows significant under density between 5° and 10° and a gap at ~-7.5° in the M92 stream in the bar potential than in the no bar potential

Future Studies

1. In future work we will investigate into whether the interaction of M92 with the bar creates some features eg: gaps.
2. We will also study the effect of the bar potential on streams whose pericenter are greater than 8 kpc.

References

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