Can we use the nearby velocity distribution to constrain the properties of the bar and the spiral arms of the MW?

Gaia capabilities

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Outline

1. INTRODUCTION
2. TEST PARTICLE ORBIT SIMULATIONS
3. GAIA CAPABILITIES
What are moving groups?

- U V W for 24000 stars:
  Nordström et al. (2004); Asiain et al. (1999a); Torra et al. (2000);
  Reid et al. (2002); Bochanski et al. (2005); Famaey et al. (2005)

- Wavelet denoising

Antoja et al. 2008

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What are moving groups?

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Interest of moving groups

Orbital and resonant effects of the MW spiral arms and bar

Kalnajs (1991)
Only for particular bar orientation and pattern speed!!

MOVING GROUPS:
tool to constrain the properties of the bar and the spiral arms!

SPIRAL ARMS & BAR:
- Mass or strength?
- Pattern speed?
- Orientation?
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Simulation method

- **Initial Conditions:**
  - IC1 cold disk
  - IC2 warm disk
  - IC3 hot disk

- **Potential Model for the MW:**
  - Integrated test particle orbits

- **Analysis of the velocity distribution**

  Integration of test particle orbits

- **Potential Model for the MW:**

  AXISYMMETRIC

  SPIRAL ARMS (Pichardo et al. 2003b)

  BAR (Pichardo et al. 2004)
Strong imprints on the velocity plane, specially near the arms

Branches resembling the observed ones

Crowding at $V \sim -40 \text{ km s}^{-1}$, not only the bar!
Imprints of the spiral arm: vertex deviation
Imprints of the spiral-bar model IC1

Can we use the velocity distribution to constrain the bar and the spiral arms?
Imprints of the spiral-bar model IC1

Can we use the velocity distribution to constrain the bar and the spiral arms?
Direct spiral arm kinematic perturbation

Observationally:
Monguio et al. 2010, in prep.

Theoretically:
Romero-Gomez et al. 2010, in prep.
Testing kinematic perturbation of different models:
- Lin&Shu perturbation?
- Invariant manifolds of the bar potential?
1 INTRODUCTION

2 TEST PARTICLE ORBIT SIMULATIONS

3 GAIA CAPABILITIES
Particular cases:

1) Scutum-Centaurus tangency
2) Perseus arm in the anti-center

Why these positions?
- Particularly rich in resonant substructure
- Regions that experience the spiral arm perturbation

Spitzer/GLIMPSE (Benjamin et al. 2005)
Scutum-Centaurus tangency

\[ l = 305^\circ, \beta = 0^\circ, \]
\[ \text{dist} = 6.9\, \text{kpc} \]

\[ K4-5\, \text{III} \]
\[ M_V, (V-I)_i, A_V, A_I \]

\[ G \sim 18 \]
\[ e_\pi \sim 90\, \mu\text{as} \, (62\%\, !!) \]
\[ e_\mu \sim 50\, \mu\text{as/yr} \]
No radial velocities!!

- Radial velocities needed
- Better distances
Scutum-Centaurus tangency

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Model

+ GAIA errors
+ survey $e_{VR} = 2 \text{ km s}^{-1}$

+ GAIA errors
+ survey $e_{VR} = 10 \text{ km s}^{-1}$
Perseus arm in the anti-centre

\[ l = 180^\circ, \beta = 0^\circ, \]
\[ \text{dist} = 2.0 \text{kpc} \]

\[ M_V, (V-I)_i, \quad A_V, A_I \]

<table>
<thead>
<tr>
<th>ST</th>
<th>G</th>
<th>( e_\pi (\mu\text{as}) )</th>
<th>( e_\mu (\mu\text{as}) )</th>
<th>( e_{VR} (\text{km s}^{-1}) )</th>
</tr>
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<tbody>
<tr>
<td>B5 V</td>
<td>13</td>
<td>8 (2%)</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>K5 III</td>
<td>13</td>
<td>8 (2%)</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>A5 V</td>
<td>15</td>
<td>23 (5%)</td>
<td>12</td>
<td>20</td>
</tr>
</tbody>
</table>
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Very good job in the Perseus arm!
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