Gaia vs Hipparcos
Parallax Measurements

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United Nations/Jordan Workshop: Global Partnership in Space Exploration and Innovation
25-28 March 2019
Amman, Jordan
Hipparcos Satellite

Measured 2.5 million stars 1989-1993. Distance, positions, motions and magnitude.
The Hipparcos astrometric catalog, containing 118218 stars, is one of the final products of the Hipparcos mission and was released in June 1997. The Hipparcos and Tycho catalogues were constructed under the responsibility of large scientific teams.
A new reduction of the astrometric data as produced by the Hipparcos mission has been published, claiming accuracies for nearly all stars brighter than magnitude $Hp = 8$ to be better, by up to a factor 4, than in the original catalogue.
Gaia Satellite
Gaia Data Release 2 (DR2) was released on 25 April 2018. It contains Astrometric Data, photometric Data, Radial Velocities, variable stars, and solar system object.
### Hipparcos vs Gaia Missions

<table>
<thead>
<tr>
<th></th>
<th>Hipparcos</th>
<th>Gaia</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Magnitude limit</strong></td>
<td>12</td>
<td>20 mag</td>
</tr>
<tr>
<td><strong>Completeness</strong></td>
<td>7.3 – 9.0</td>
<td>20 mag</td>
</tr>
<tr>
<td><strong>Bright limit</strong></td>
<td>0</td>
<td>6 mag</td>
</tr>
<tr>
<td><strong>Number of objects</strong></td>
<td>118 300</td>
<td>26 million to V = 15</td>
</tr>
<tr>
<td><strong>Telescope</strong></td>
<td>Schmidt telescope</td>
<td>Three-mirror anastigmat</td>
</tr>
<tr>
<td><strong>Mirror diameters</strong></td>
<td>29 cm</td>
<td>(145 x 50) cm</td>
</tr>
<tr>
<td><strong>Photometry</strong></td>
<td>2-colour (B and V)</td>
<td>Low-res. spectra to V = 20</td>
</tr>
<tr>
<td><strong>Radial velocity</strong></td>
<td>None</td>
<td>15 km/s to V = 16-17</td>
</tr>
</tbody>
</table>
Aims of the study:

- To compare the parallax measurements results of Hipparcos old and new catalogues with those of Gaia.
- To answer the question “Was F. van Leeuwen right in his Validation of the new Hipparcos reduction?” depending on the parallax measurements of the close visual binary stars (CVBS) with solved orbits.
Analysis Standard

Parallax Error

### Table showing Mean and Statistical Tests

<table>
<thead>
<tr>
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<tbody>
<tr>
<td><strong>Mean of the standard error</strong></td>
<td>0.0562</td>
<td>0.1032</td>
<td>0.1284</td>
</tr>
<tr>
<td><strong>ANOVA Test</strong></td>
<td>P&lt;0.0001</td>
<td>**</td>
<td>****</td>
</tr>
<tr>
<td><strong>Brown-Forsythe test</strong></td>
<td>P=0.0012</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td><strong>Bartlett's test</strong></td>
<td>P&lt;0.0001</td>
<td>****</td>
<td>****</td>
</tr>
</tbody>
</table>

Table shows the mean and statistical tests with P-values to determine if there is a significant difference.

- P= 0.05  →  *  
- P= 0.001 →  **  
- P= 0.0001 →  ***  
- P< 0.0001 →  ****  

Sunday, March 31, 2019  Gaia vs Hipparcos parallax measurements
distributions of parallax (\(\Pi\)) with standard error (\(\delta\Pi /\Pi\)) for Hipparcos 1997 catalogue, Van Leeuwen Reduction 2007, Gaia (DR2) 2018, and fitting curves.
Fitting curves to distributions of parallaxes and standard error of parallaxes, that show the difference between Hipparcos and Tycho catalogue 1997, Van Leeuwen validation 2007, and Gaia data 2018 (DR2).
Parallax difference

Gaia (DR2) 2018 parallax measurements with Hipparcos and Tycho 1997, Van Leeuwen Reduction parallax measurements, and the fitting lines to show the correlation.
The fitting line of Hipparcos 1997 data, and fitting line of Hipparcos 2007 parallax measurements with Gaia parallax measurements from (0-20) mas.
The fitting line of Hipparcos 1997 data, and fitting line of Hipparcos 2007 parallax measurements with Gaia parallax measurements from (20-40) mas.
The fitting line of Hipparcos 1997 data, and fitting line of Hipparcos 2007 parallax measurements with Gaia parallax measurements from (40-200) mas.
The fitting line of Hipparcos 1997 data, and fitting line of Hipparcos 2007 parallax measurements with Gaia parallax measurements from (200-600) mas.
Distance difference

Conclusions

- Gaia data 2018 (DR2) have the lowest parallax measurement errors comparing with Van Leeuwen Reduction 2007 and Hipparcos and Tycho 1997, while Hipparcos and Tycho 1997 has the highest errors.

- Depending on Gaia data and relying on its accuracy of the parallax measurements for the CVBS, we found that F. van Leeuwen was right in his validation of the new Hipparcos reduction for stars farther than 50 parsecs (parallax<=20 mas), while he wasn’t for stars closer than 50 pc.
Thank You