



# Gaia vs Hipparcos

## Parallax Measurements

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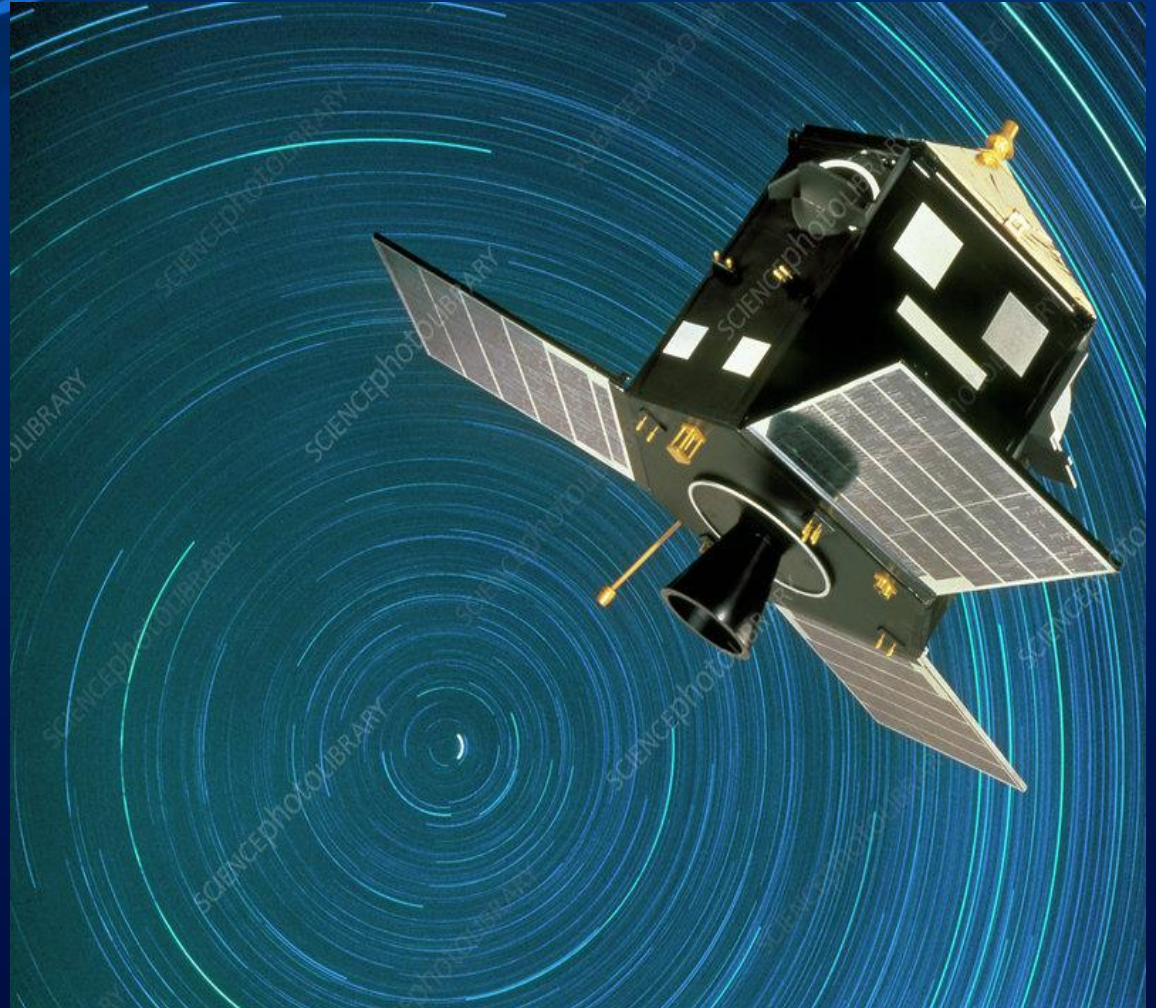
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# Hipparcos Satellite

Measured 2.5  
million stars  
1989-1993.  
Distance,  
positions,  
motions and  
magnitude



# Hipparcos and Tycho catalogue

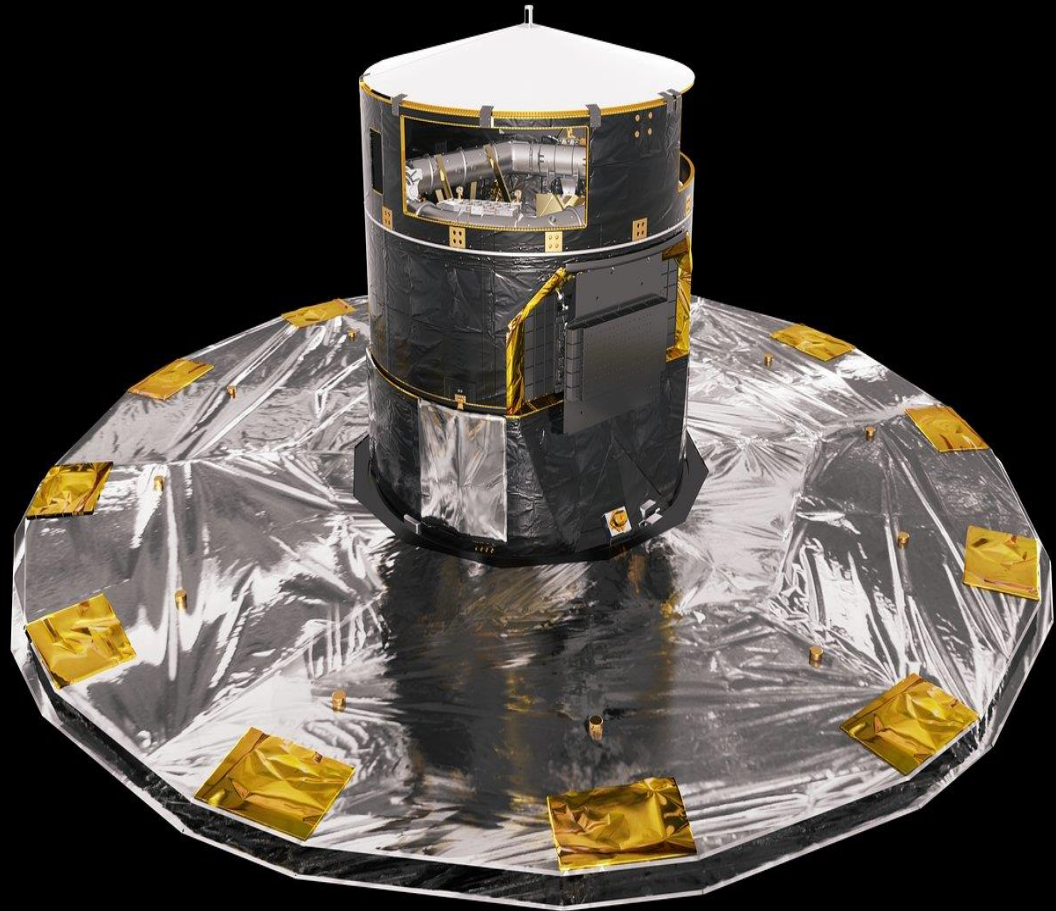
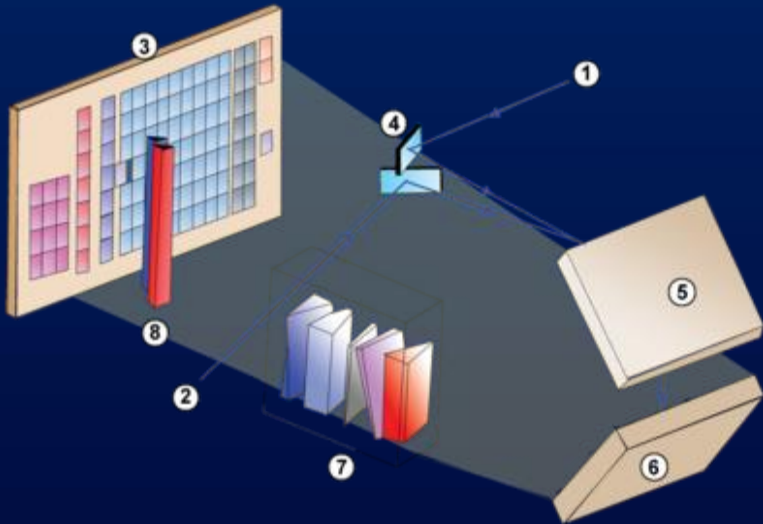
The Hipparcos astrometric catalog, containing 118218 stars, is one of the final products of the Hipparcos mission and was released in June 1997. The Hipparcos and Tycho catalogues were constructed under the responsibility of large scientific teams.

# Van Leeuwen Validation

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  $H_p = 8$  to be better, by up to a factor 4, than in the original catalogue.



# Gaia Satellite



# Gaia Data Release 2 (DR2)

Gaia Data Release 2 was released on 25 April 2018.

It contains Astrometric Data, photometric Data, Radial Velocities, variable stars, and solar system object.

# Hipparcos vs Gaia Missions

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



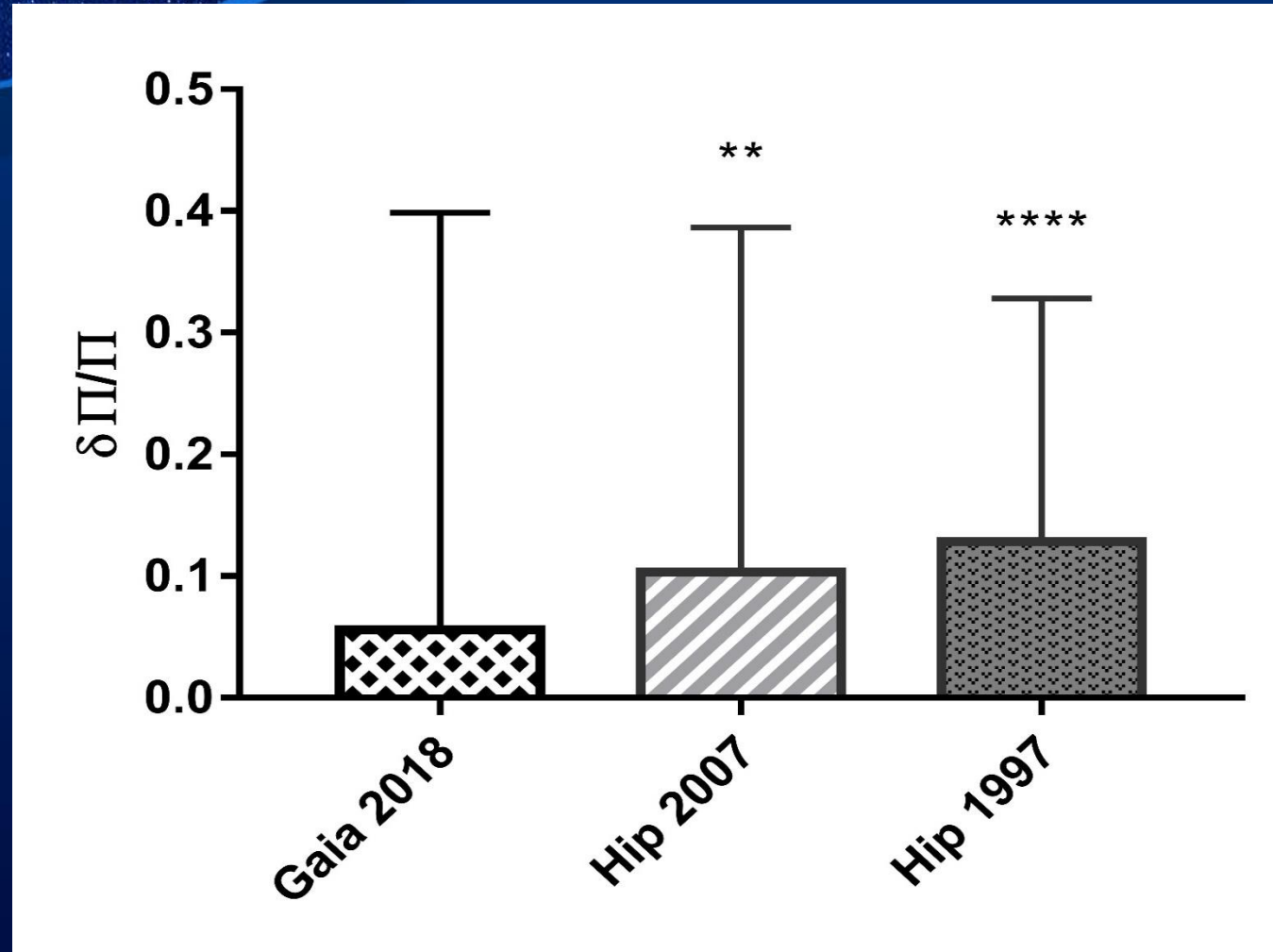
# Aims of the study:

- 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

ANOVA Statistical analysis for Mean/Standard Deviation to standard error of Hipparcos 1997 catalogue, and Van Leeuwen Reduction 2007, and Gaia data (DR2) 2018.



# Statistical Test

Table show Mean and the Statistical test and P-value to show If we have significant or not

$P = 0.05$   $\longrightarrow$  \*

$P = 0.001$   $\longrightarrow$  \*\*

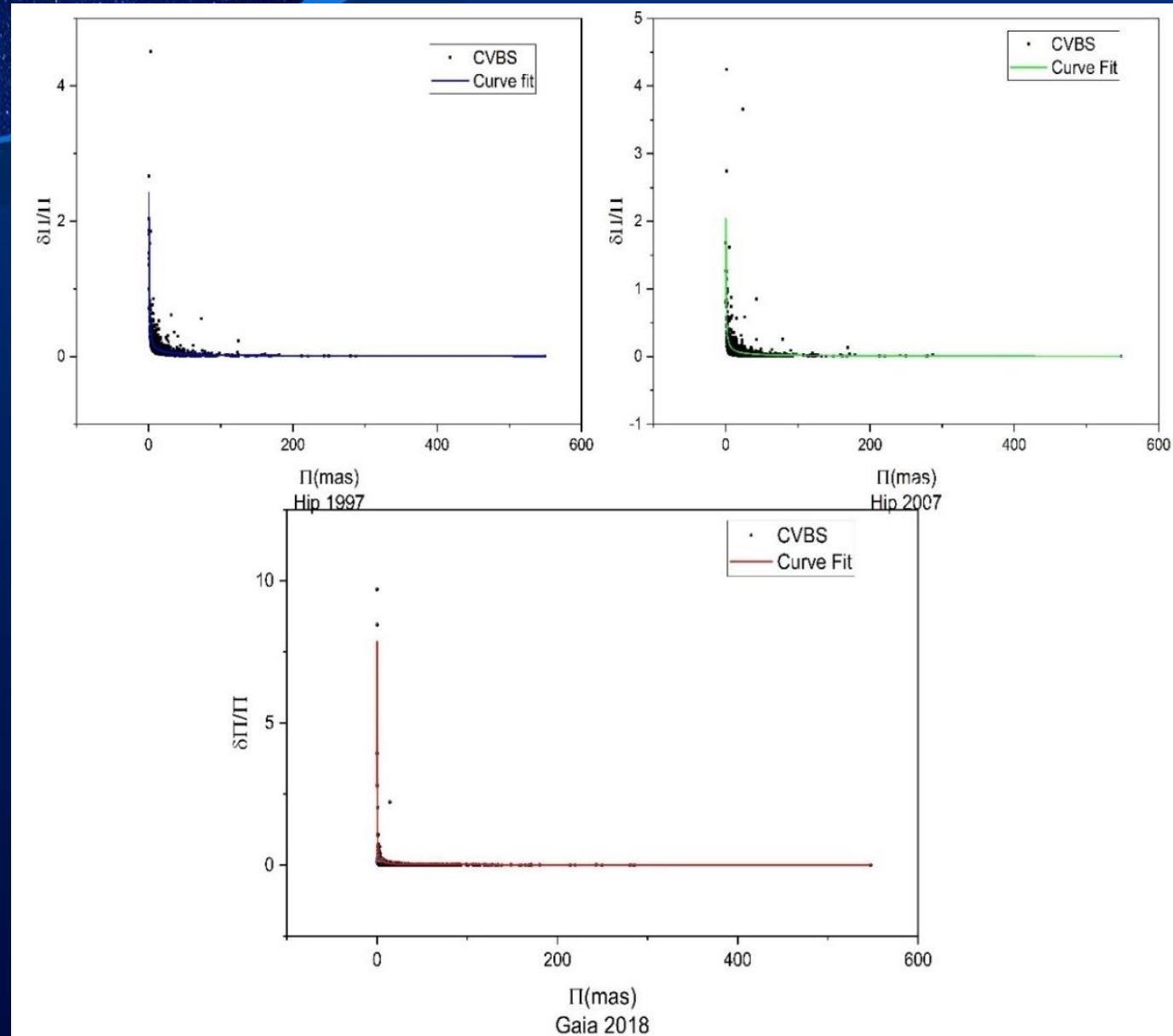
$P = 0.0001$   $\longrightarrow$  \*\*\*

$P < 0.0001$   $\longrightarrow$  \*\*\*\*

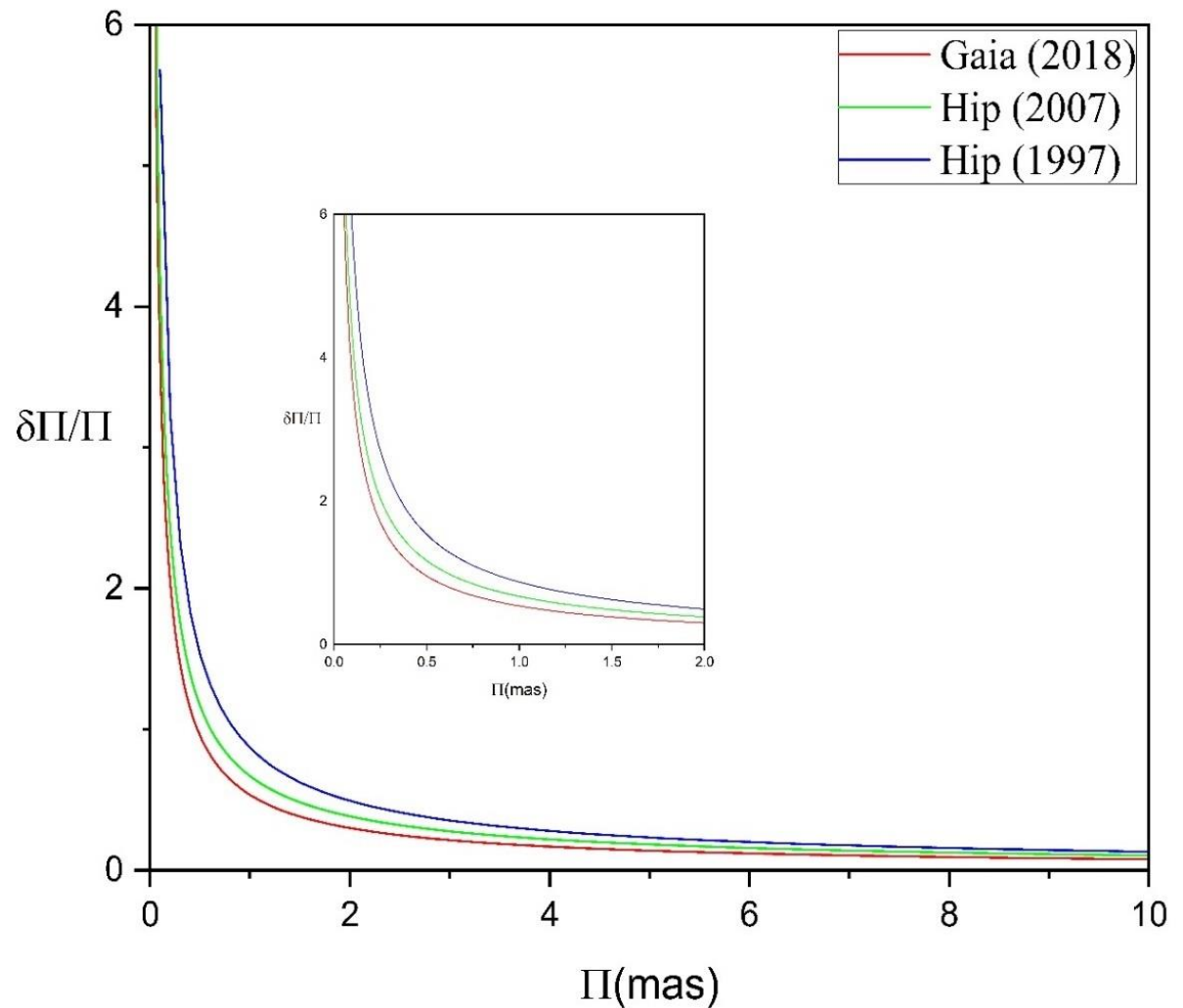
	Gaia 2018	Hip 2007	Hip 1997
<b>Mean of the standard error</b>	<b>0.0562</b>	<b>0.1032</b>	<b>0.1284</b>
<b>ANOVA Test</b>	<b><math>P &lt; 0.0001</math></b>	<b>**</b>	<b>****</b>
<b>Brown-Forsythe test</b>	<b><math>P = 0.0012</math></b>	<b>**</b>	<b>**</b>
<b>Bartlett's test</b>	<b><math>P &lt; 0.0001</math></b>	<b>****</b>	<b>****</b>

# Parallax error difference

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 parallax and standard error of parallax, 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

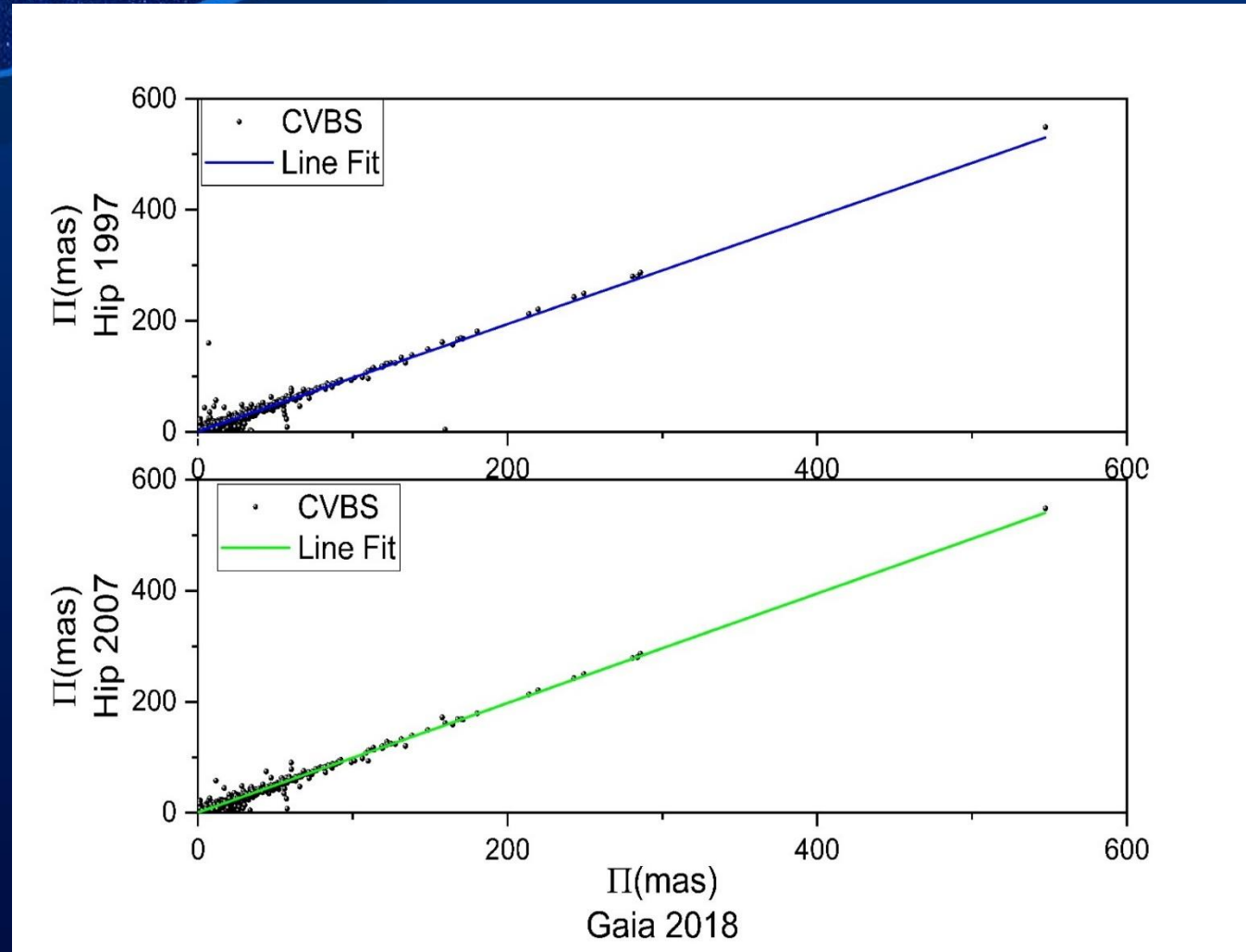
Reduction parallax

measurements,

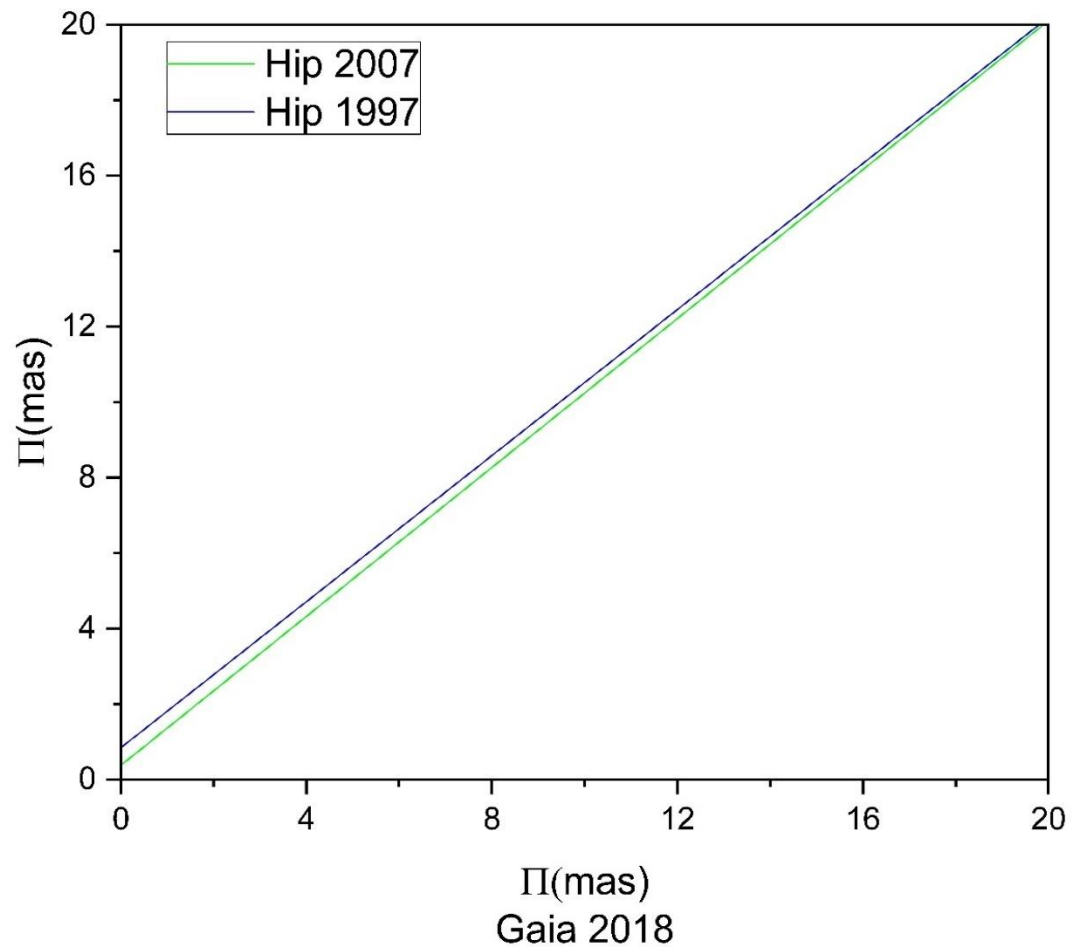
and the fitting lines

to show the

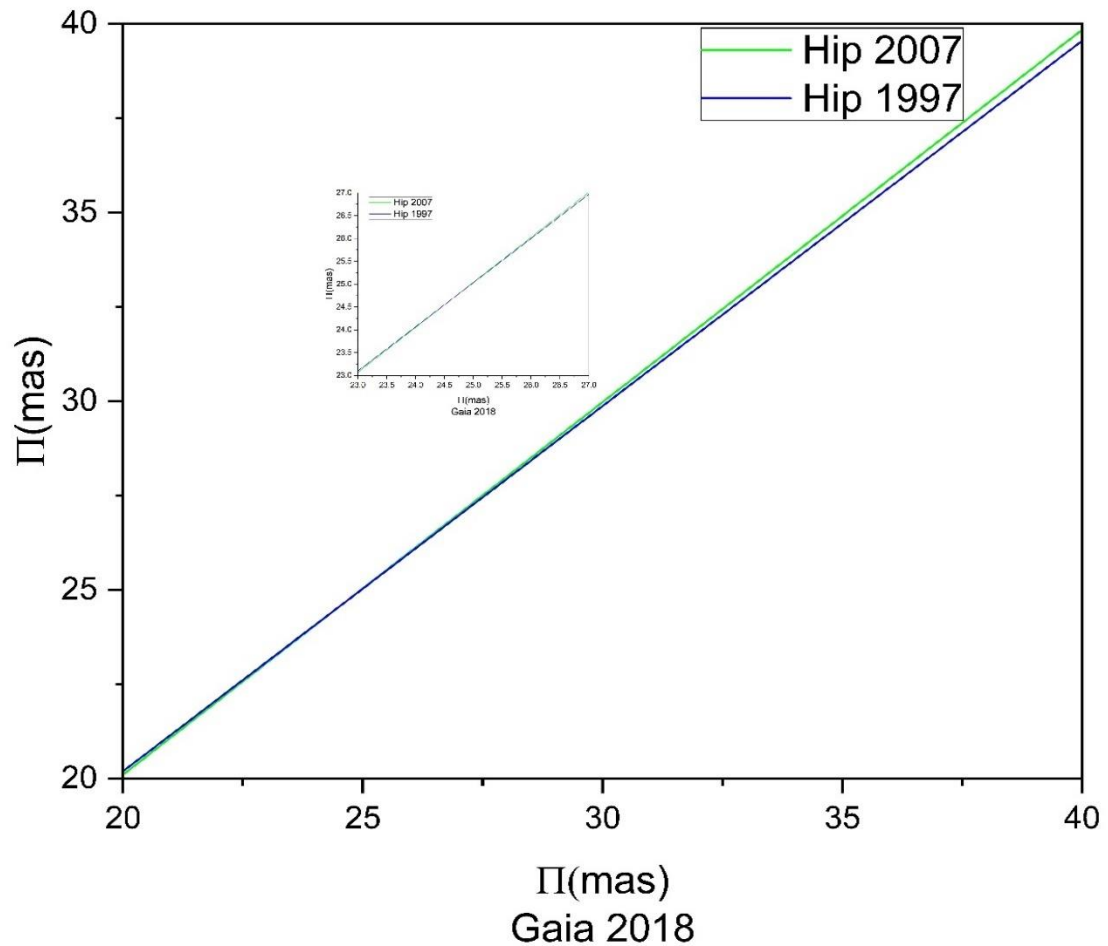
correlation.



The fitting line of Hipparcos 1997 data, and fitting line of Hipparcos 2007 parallax measurements with Gaia parallax measurements from (0-20) mas.

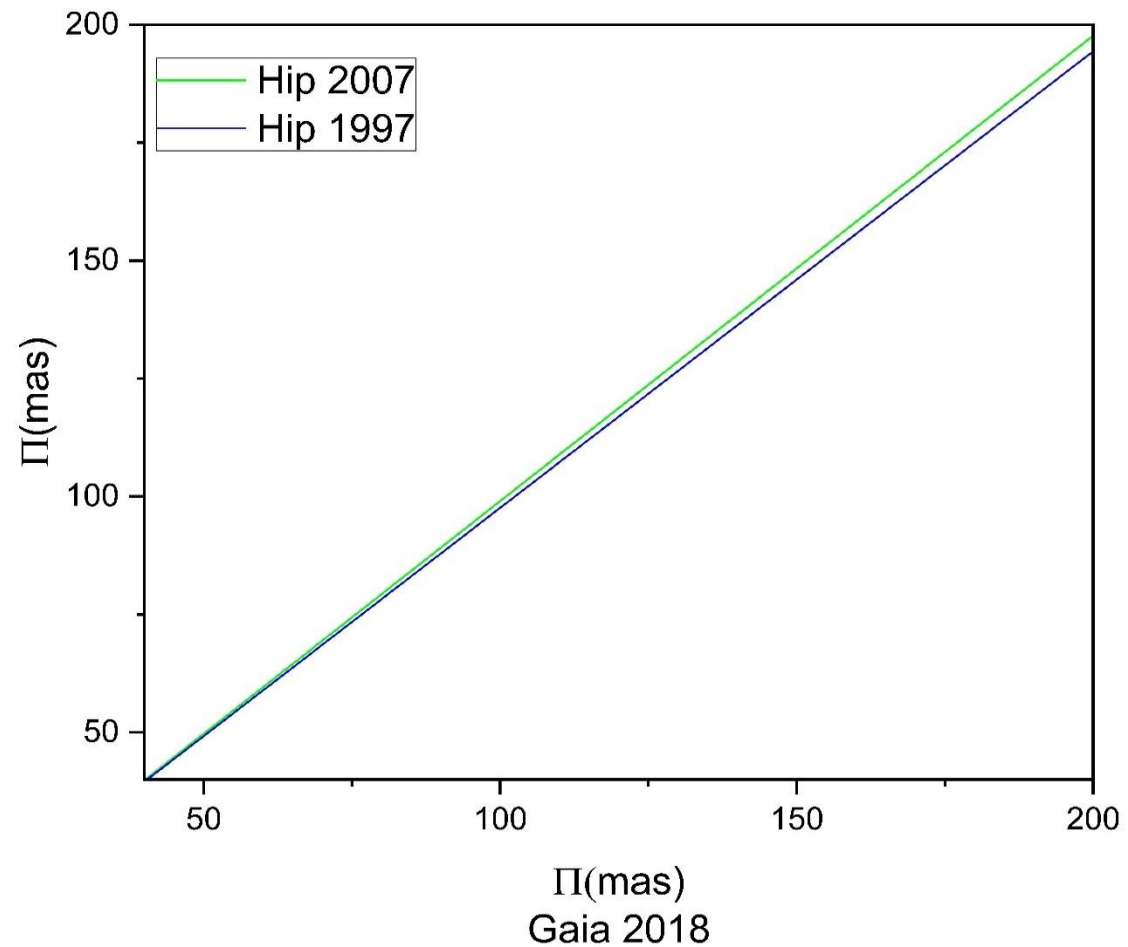


The fitting line of Hipparcos 1997 data, and fitting line of Hipparcos 2007 parallax measurements with Gaia parallax measurements from (20-40) mas.

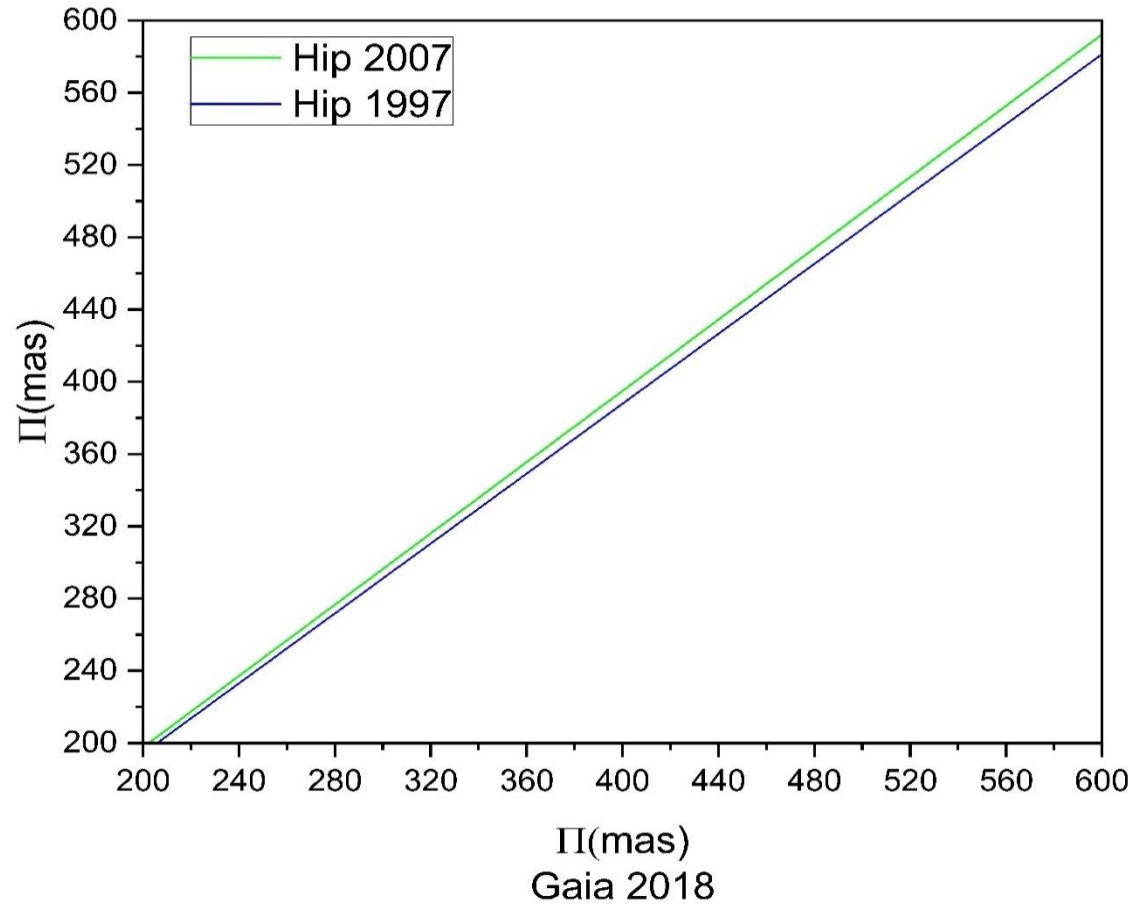




The fitting line of Hipparcos 1997 data, and fitting line of Hipparcos 2007 parallax measurements wit Gaia parallax measurements from (40-200) mas.

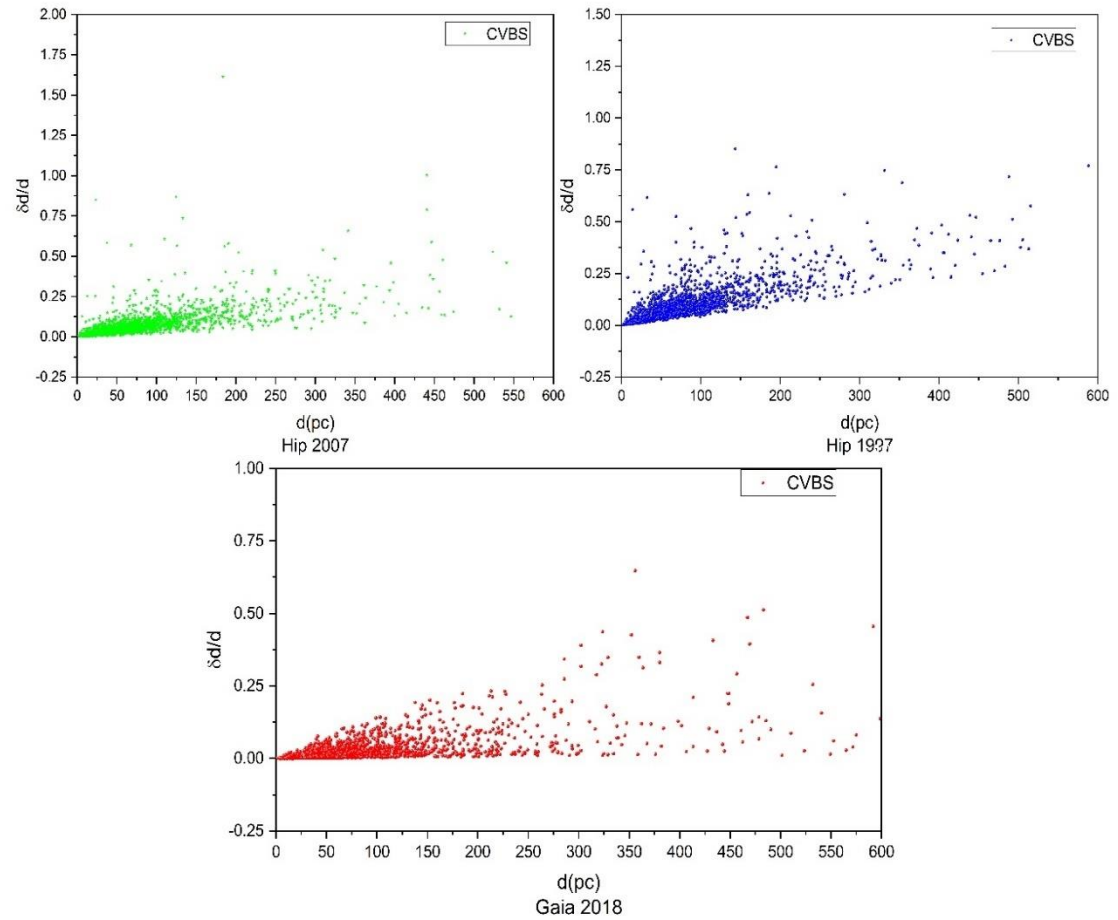


The fitting line of Hipparcos 1997 data, and fitting line of Hipparcos 2007 parallax measurements with Gaia parallax measurements from (200-600) mas.



# Distance difference

Distributions of distance ( $d$ ) in parsec with standard error ( $\delta d / d$ ) for Van Leeuwen Validation 2007, Hipparcos and Tycho catalogue 1997, Gaia (DR2) 2018.



# 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 ( $\text{parallax} \leq 20 \text{ mas}$ ), while he wasn't for stars closer than 50 pc.



# Thank You