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Testing planes of dwarf galaxies with a correlation function

Master 1 internship, year 2020

from Alex Hubert & Axel Rymar

Mentor : Oliver Müller

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Dwarf galaxies

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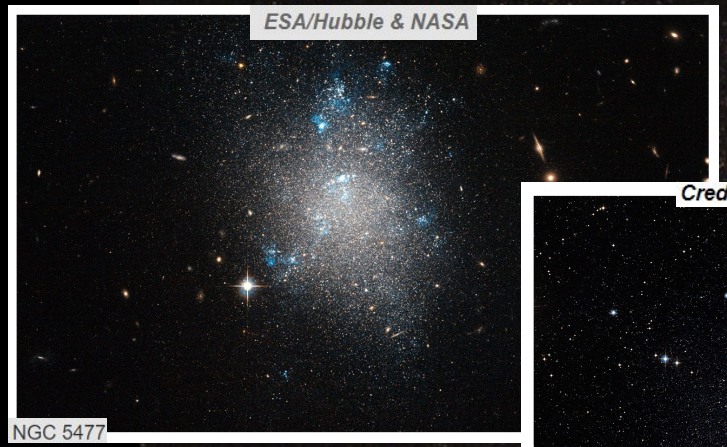

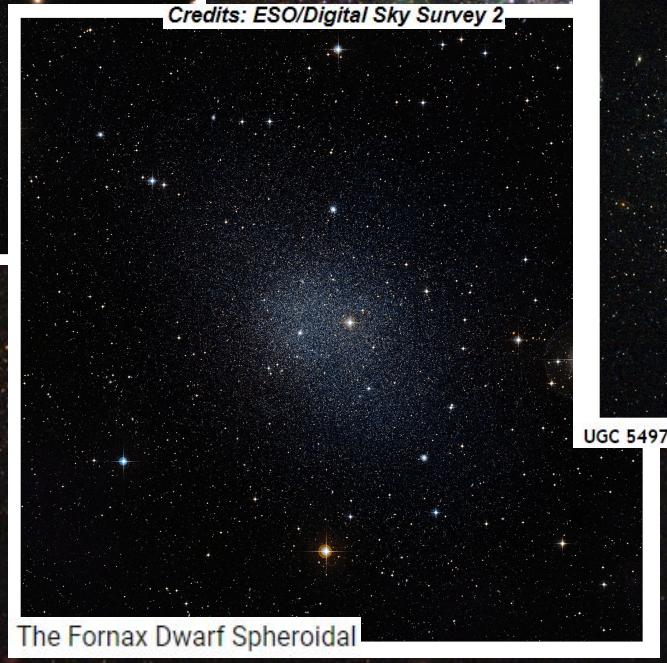

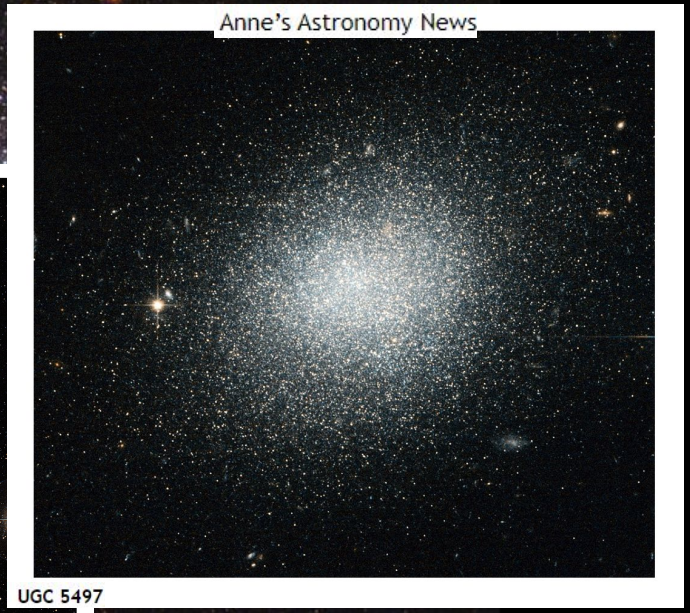

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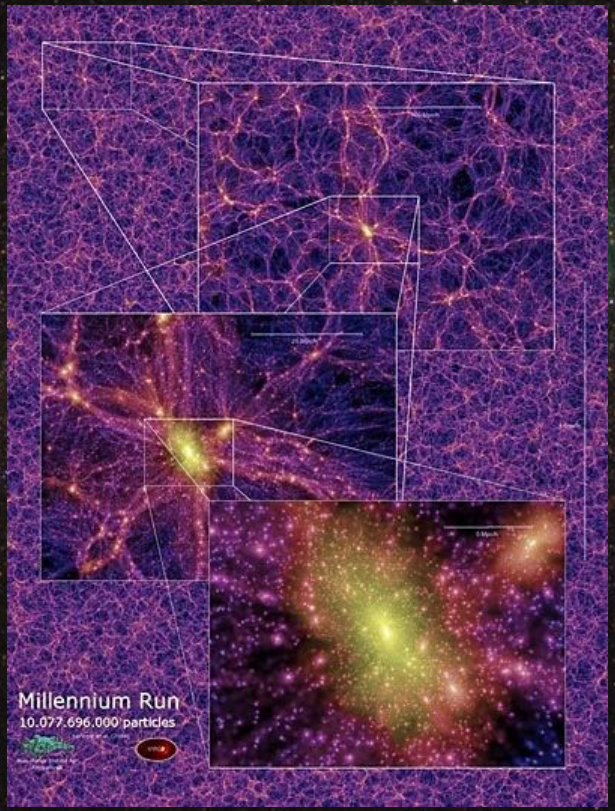
Model ΛCDM :

Proportions in the Universe :

- Matter and energy : 5%
- Dark matter : 27%
(85% of the total mass)
- Dark energy : 68%



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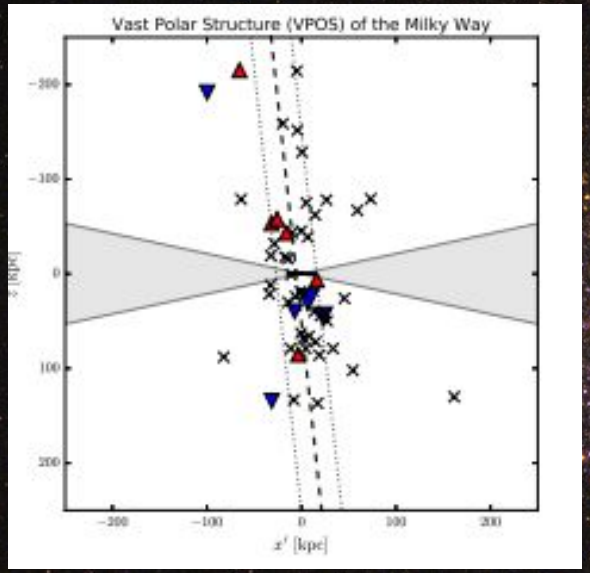
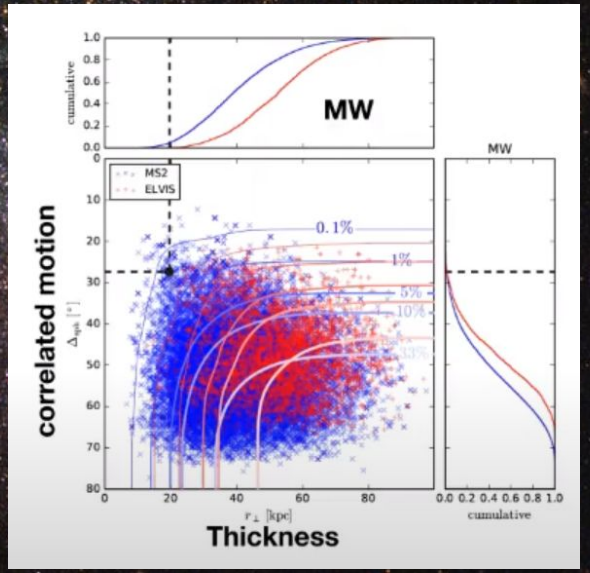
Satellite planes, is the Local Group special ?





Credits :Pawlowski (2018)

Plane Fitting method

$$\boldsymbol{r}_0 = \frac{1}{N}\sum_{i=1}^{N}\boldsymbol{r}_i.$$

Centroid of all positions.

$$\boldsymbol{T}_0 = \sum_{i=1}^{N}\left[(\boldsymbol{r}_i - \boldsymbol{r}_0)^2 \cdot \mathbf{1} - (\boldsymbol{r}_i - \boldsymbol{r}_0)\cdot(\boldsymbol{r}_i - \boldsymbol{r}_0)^{\mathrm{T}}\right],$$

Moments of inertia tensor around the centroid.

The eigenvector of the tensor corresponding to the largest eigenvalue is the normal to the plane containing the centroid.

Method used : Pawlowski et al. 2013

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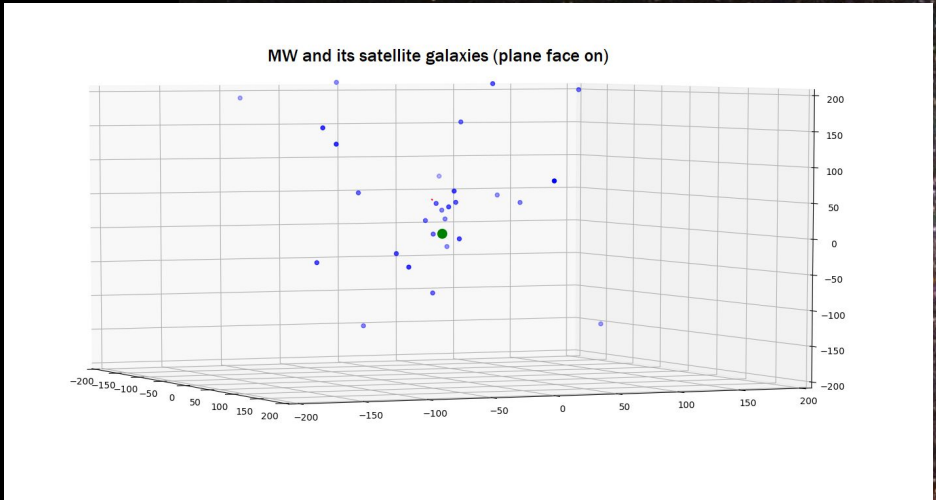
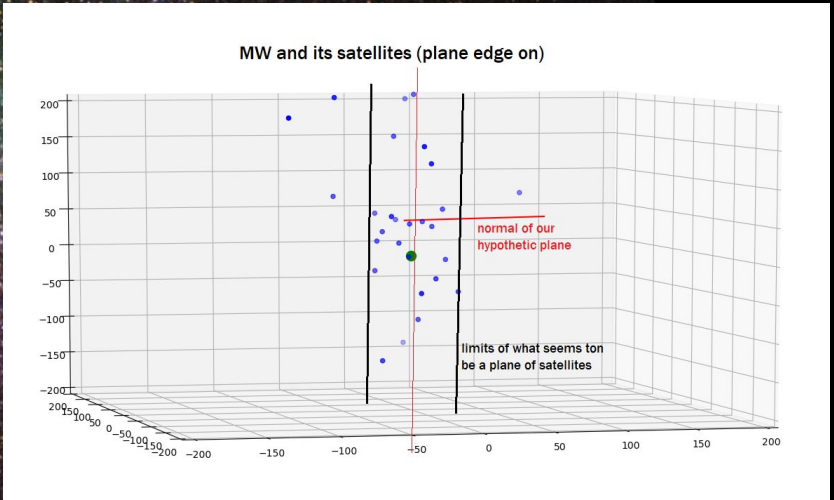
Plane Fitting method





In line with Pawlowski et al. 2013

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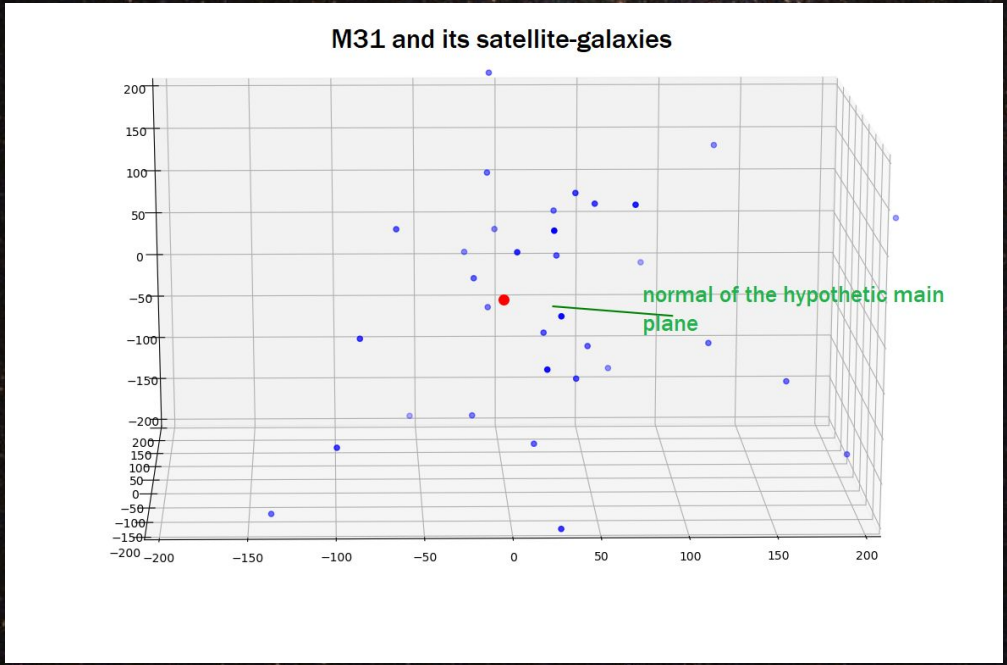
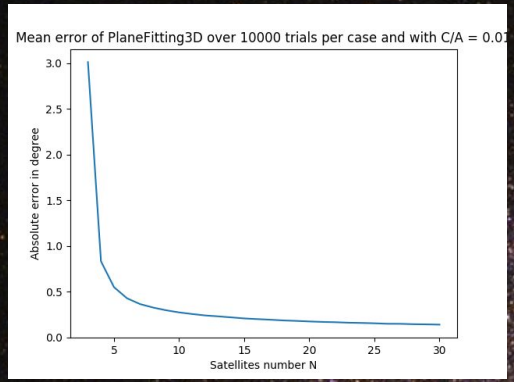
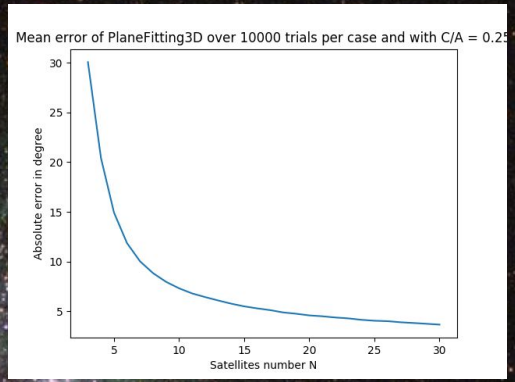
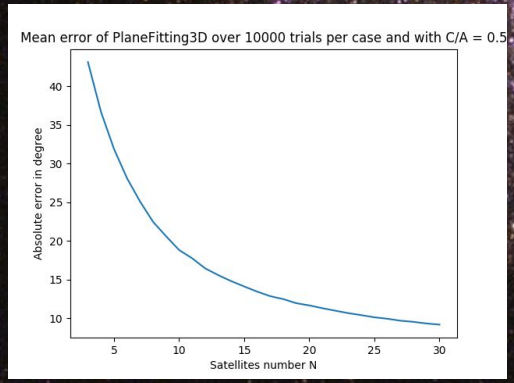
Plane Fitting method

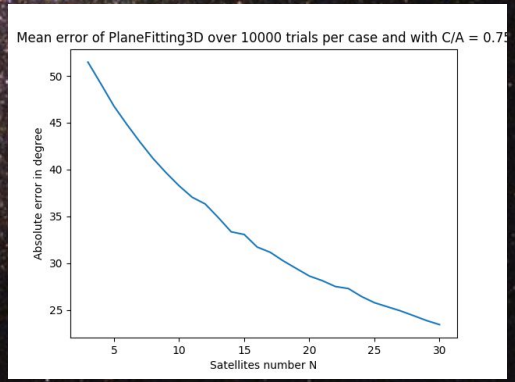


Precision of the method









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4 points correlation method

- Take every 4 combinations possible for our sample
- Apply to each combination the Plane Fitting technique to deduce its normal
- Convert all the normals in spherical coordinates to have RA and DE

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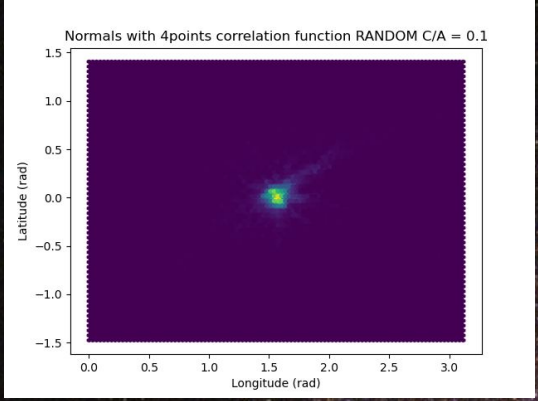
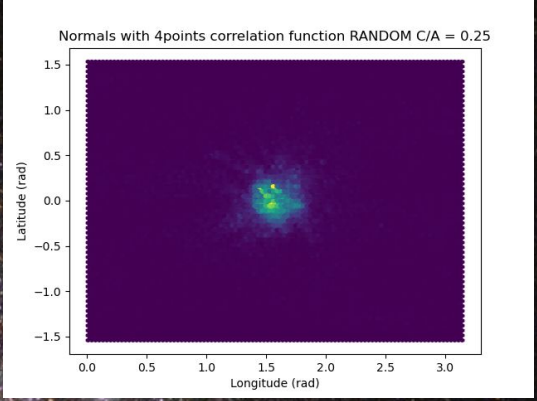
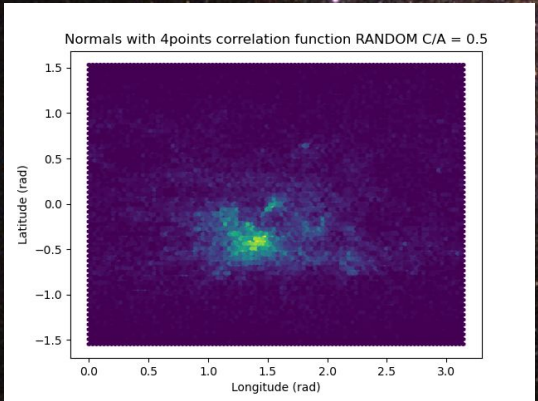
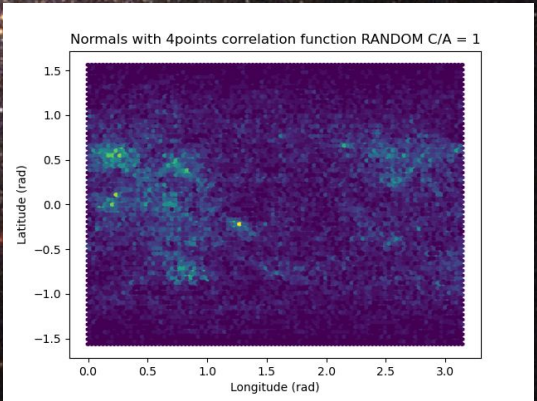
Test of randomized data









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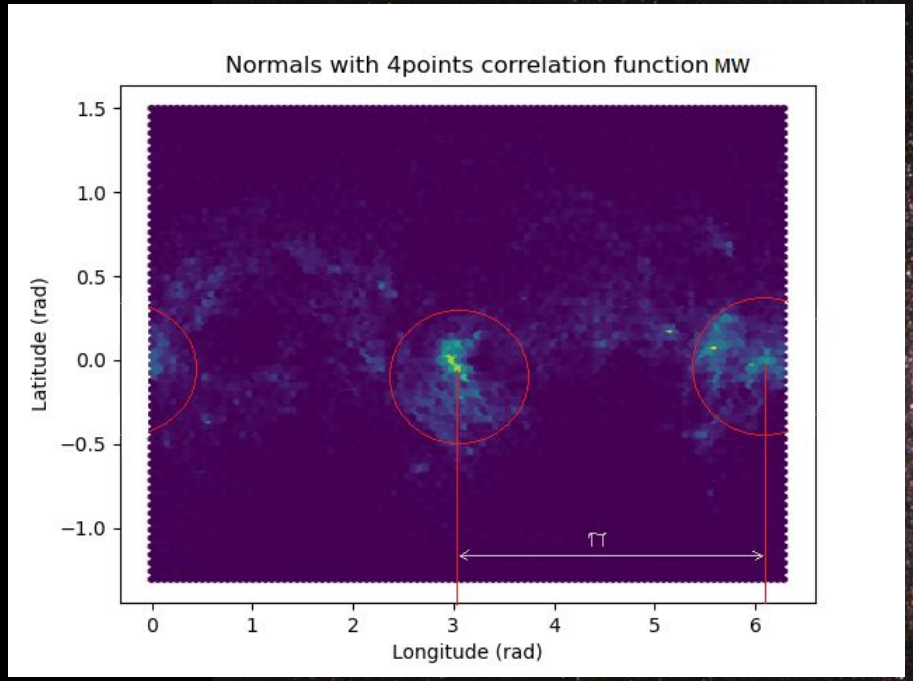
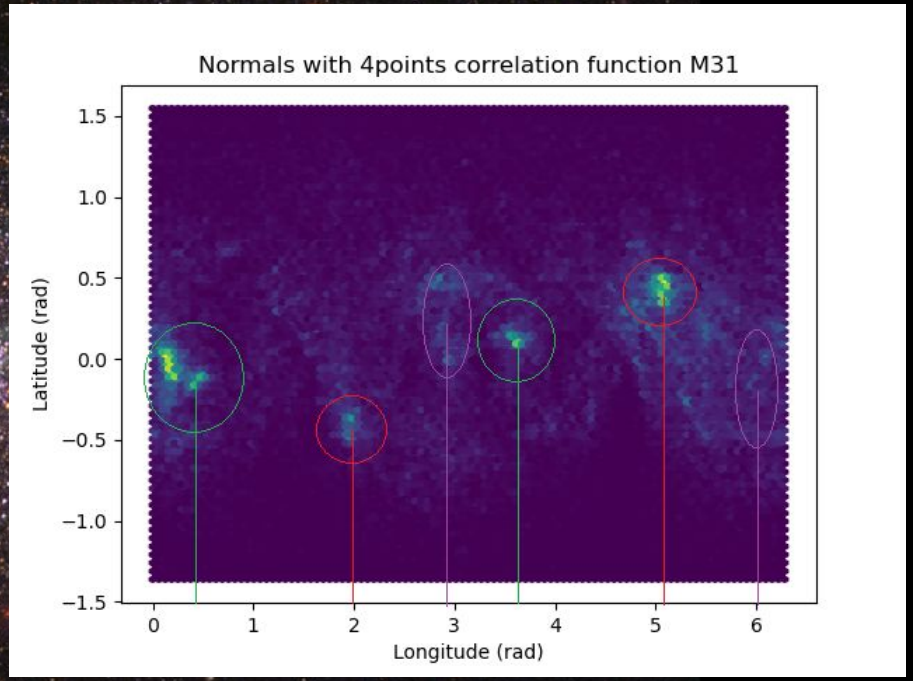
4 points correlation method





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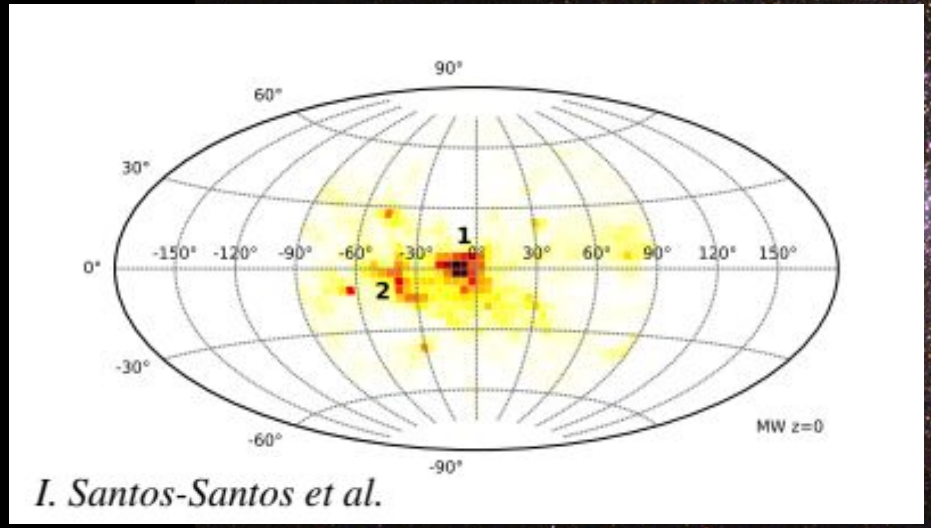
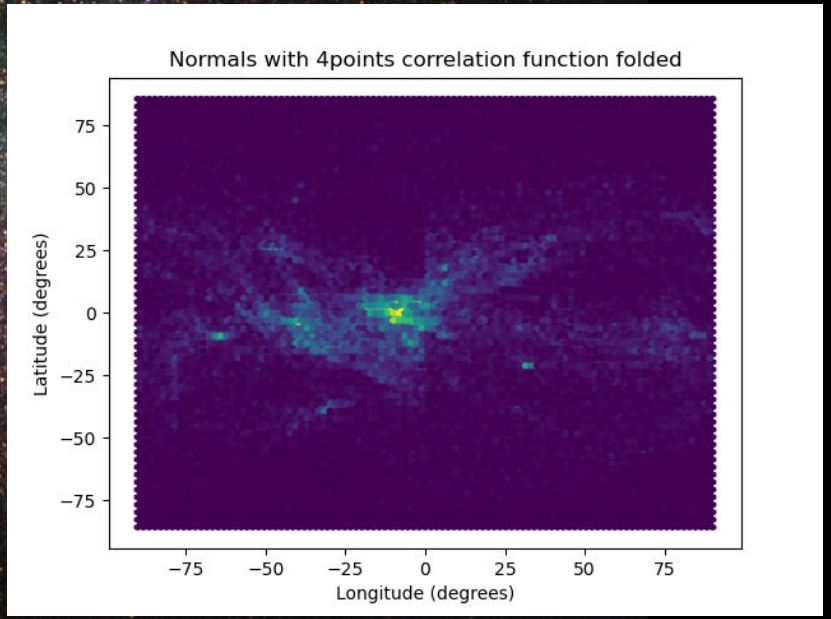
Comparison with the literature : Milky Way





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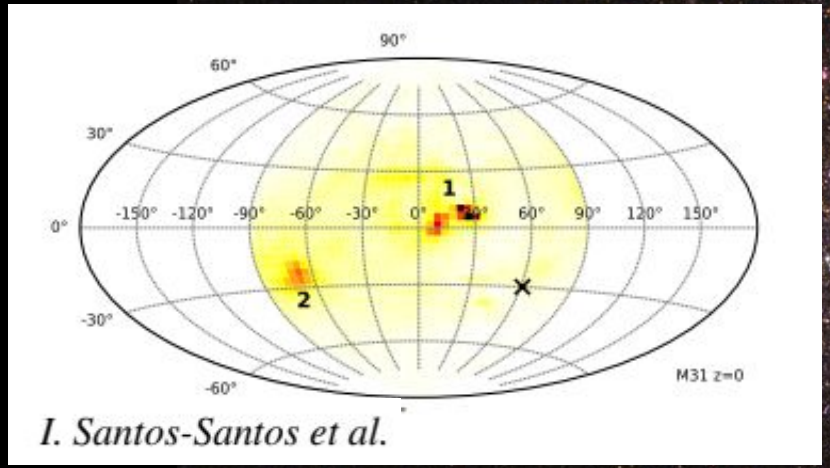
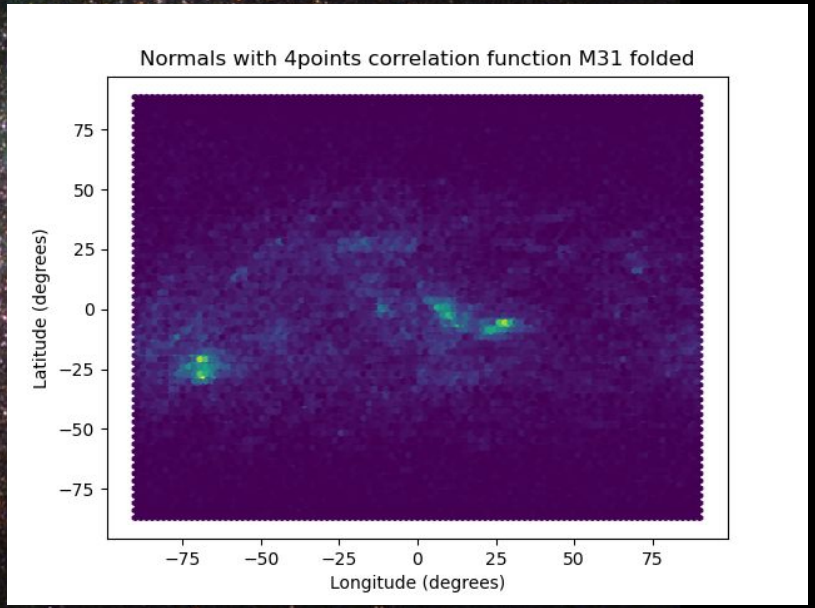
Comparison with the literature : Andromeda





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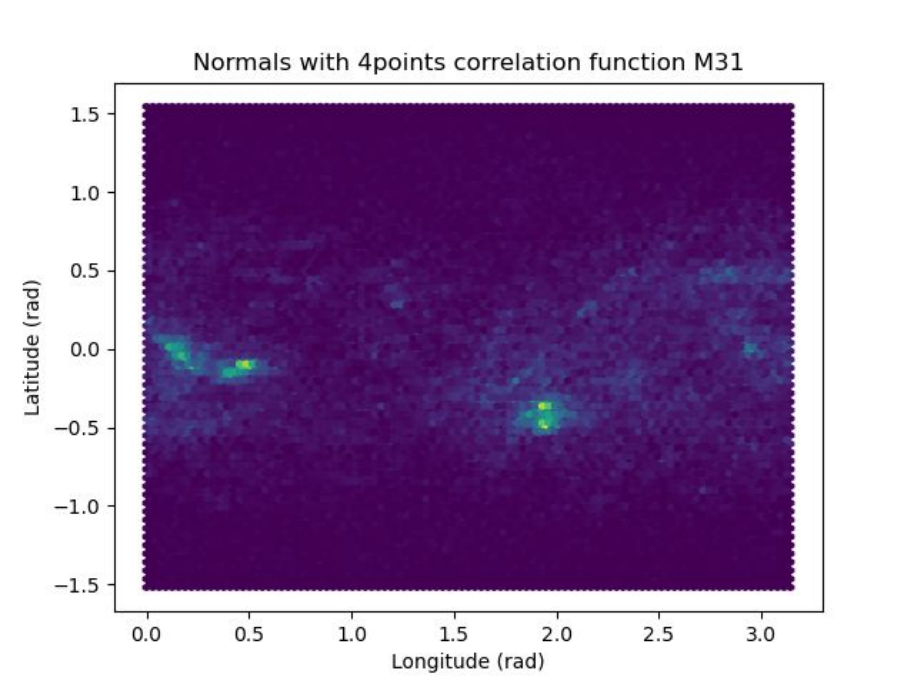
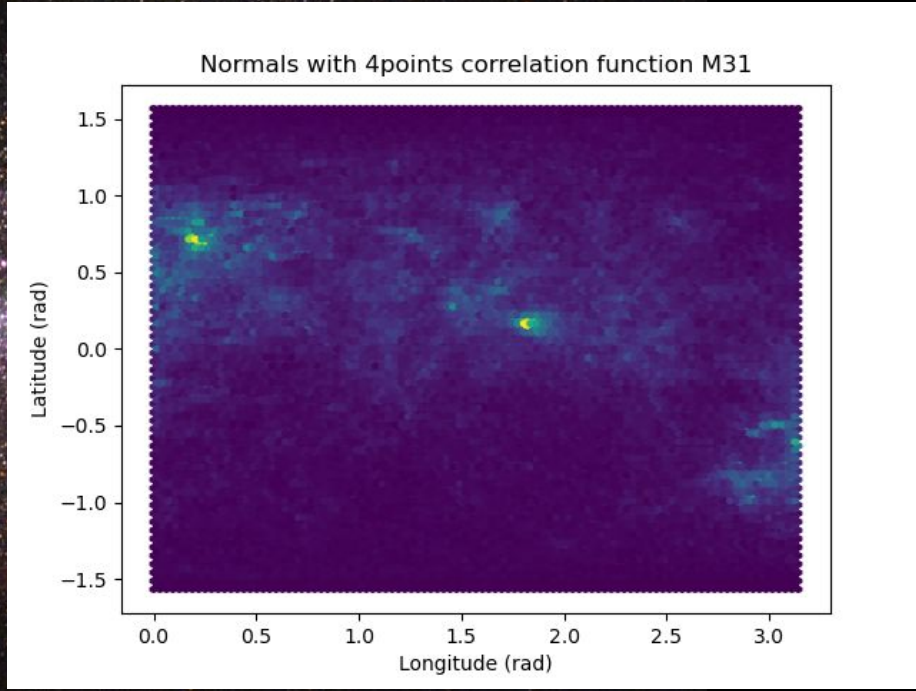
Different M31 databases





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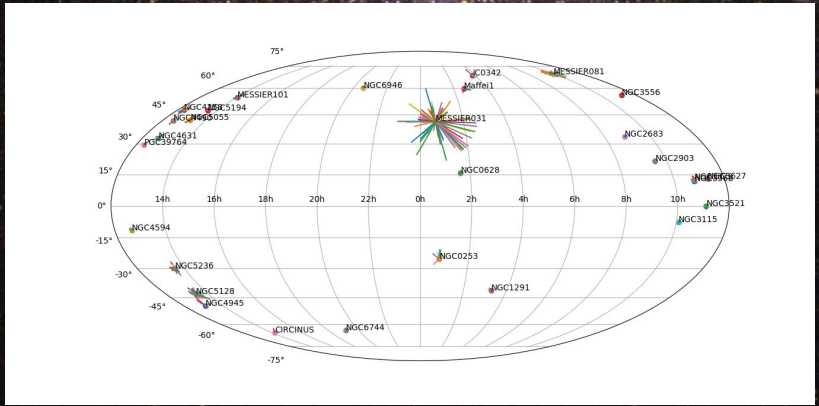
To conclude ...

- Planes of satellites verified for MW and M31
- Lack of 3d data for galaxies out of the local group
- This method should be applied on 2d data



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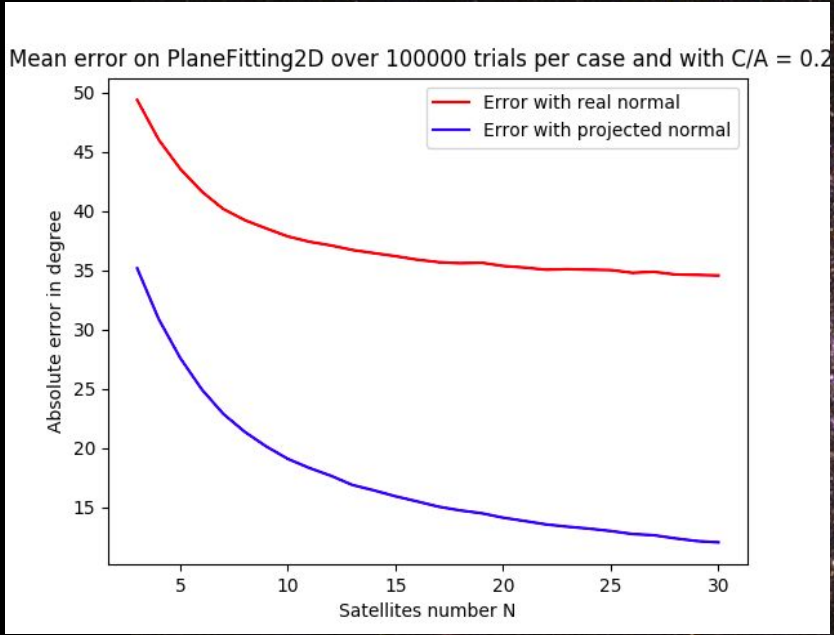
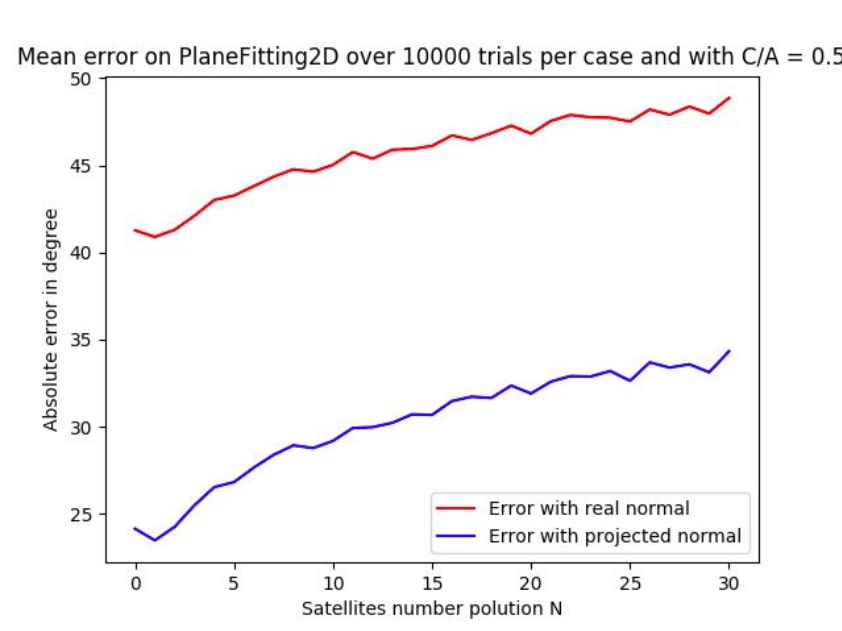
More versatil : 2D planefitting





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