TYCHO2: THE WAVELET SEARCH FOR STELLAR GROUPS

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ABSTRACT. The wavelet analysis was applied for identifying of the inhomogenities in the star distribution on the celestial sphere. The so-called Mexican Hat (MHAT) wavelet transform was used. The method was tested on simulations. The wavelet coefficients maps for the stars from Tycho2 Catalogue covering the whole celestial sphere at different scales were obtained.

1. DESCRIPTION OF THE METHOD

Tycho2 Catalogue contains 2539913 stars and more than 95% of them are fainter then 9^m. *So for the first time we can investigate the distribution of faint stars on celestial sphere*(there is no parallaxes in this catalogue). We applied the wavelet transform technique that was used in cosmology (see E. Slezak et. all [1]) for our investigation.

We use the so-called Mexican hat (MHAT) wavelet to identify the inhomogeneities in the distribution on the celestial sphere of stars from Tycho2. For a given zone of celestial sphere we define pixels i, j in 1^o bins in l- and b-directions. The wavelet transform for the scale σ of the star set was then computed in each pixel (i,j) according to:

$$W(i,j,\sigma) = \sum_n (2 - \frac{((i-l)^2 + (j-b)^2)}{\sigma^2}) e^{-\frac{(i-l)^2+(j-b)^2}{2\sigma^2}} \quad (1)$$

where l, b - galactic coordinates of the star.

2. RESULTS

The method was tested on simulations. The uniform distribution of 9000 stars on celestial sphere in the stripe with a length of 180^o and a width of 10^o with three clusters at $l \in [16^o;19^o]$, $b \in [3^o;5^o]$ of 60 stars, $l \in [85^o;88^o]$, $b \in [5^o;7^o]$ of 90 stars and $l \in [150^o;154^o]$, $b \in [4^o;6^o]$ of 80 stars had been simulated. The map of wavelet coefficients obtained with σ=2 can be seen on Fig.1.

With the aim of calibration, the method was applied to the stars from the regions with known groups such as Hyades and Pleiades. It was revealed that Hyades cluster can be identified only among Tycho2 stars brighter than 8^m. Stars fainter than 8^m form another structure that differs from Hyades in l-coordinate by 10^o (see Fig.2,3).

So it can be concluded that this method reveals the known structures, and there is a hope that some new clusters can be found .

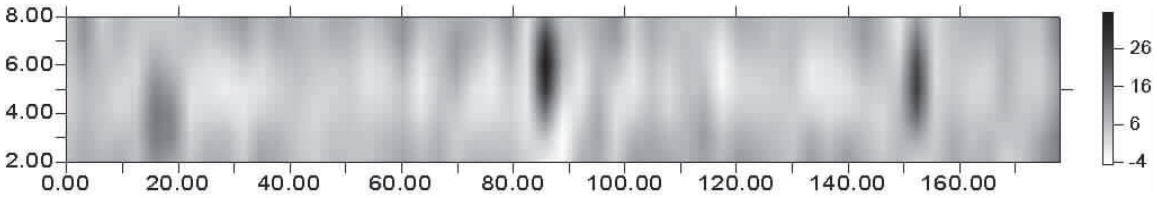

Figure 1: Map of the wavelet coefficients obtained for the stars from the simulated catalogue with $\sigma = 2$.

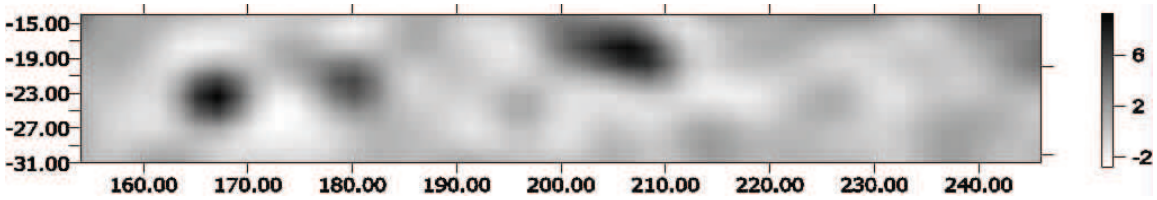

Figure 2: Map of the wavelet coefficients obtained at σ=3 for the stars from Tycho2 with V less than 8^m(in galactic coordinates).

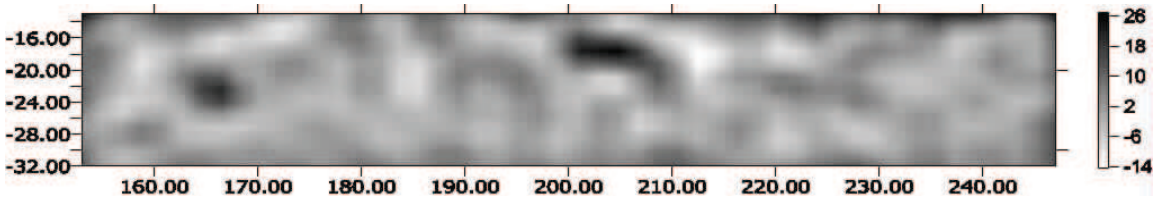

Figure 3: Map of the wavelet coefficients obtained at σ=2 for the stars from Tycho2 with V $\in$ [8^m;10^m].

The maps of wavelet coefficients for the stars from Tycho2 for the whole celestial sphere were constructed at different scales . The map of wavelet coefficients obtained for the stars from the stripe near the galactic plane with σ=1 is presented on Fig.4.

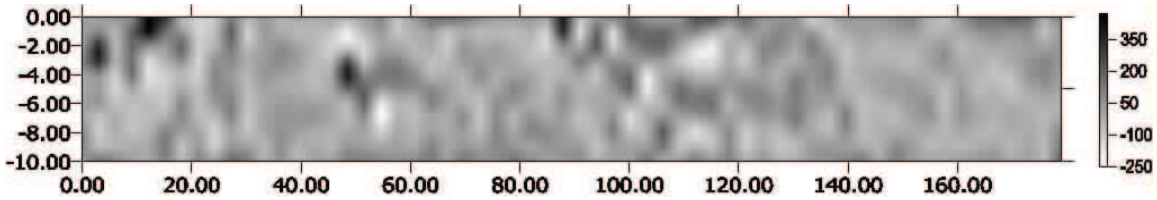

Figure 4: Map of the of the wavelet coefficients obtained at σ =1 for the stars from Tycho2.

Besides known clusters such as Pleiades and Hyades the wavelet revealed a lot of new structures among faint stars from Tycho2.

We are going to continue the research using the color indices B-V and visual magnitudes V for further studying of the membership of the detected clusters.

3. REFERENCES

[1] E.Slezak et. all, *Astron. Astrophys.*, 227, pp. 301-316, 1990.