Gravitational influence on the Oort system as a result of the close flyby of M 15

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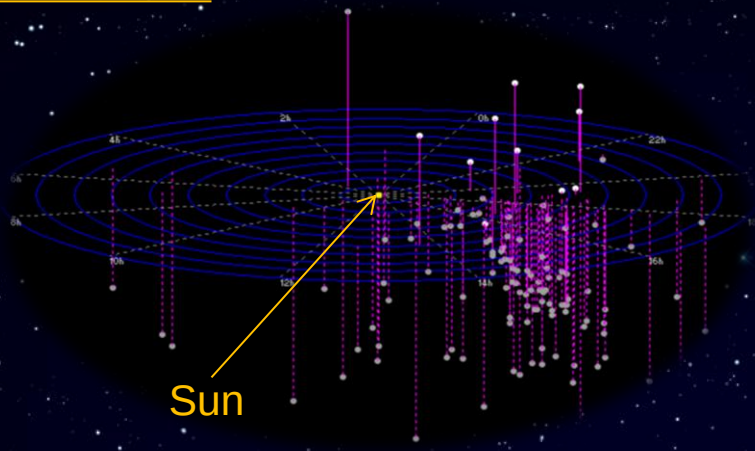
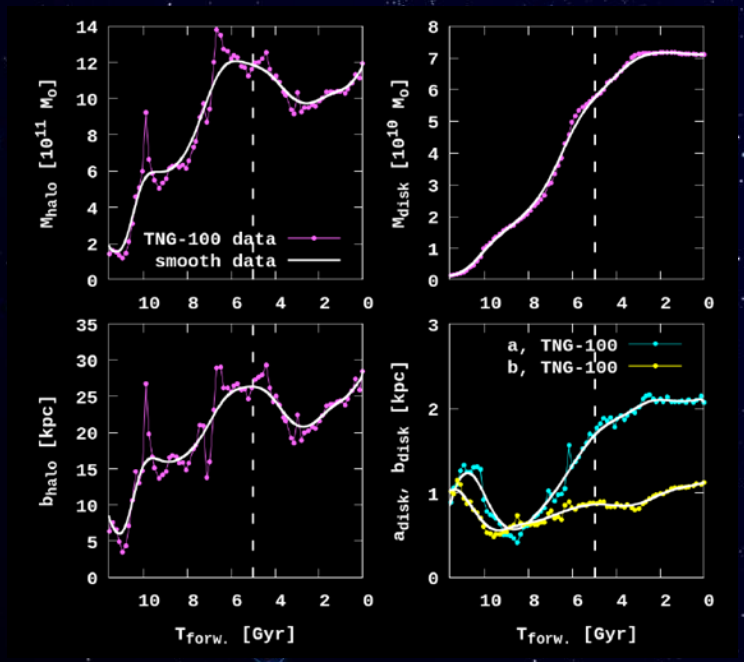


In our previous study *Ishchenko M., et al., 2024b, A&A, 689, A178* we examined the statistics of the interaction between globular clusters (GCs) and the Solar System over a – five-billion-year period.

Our aim was to estimate the gravitational influence of GCs' flybys on the Oort cloud system.

We identified 35 GCs that could potentially experience close encounters with the Sun across throughout the Sun's entire lifetime in time variating MW-like external potential.

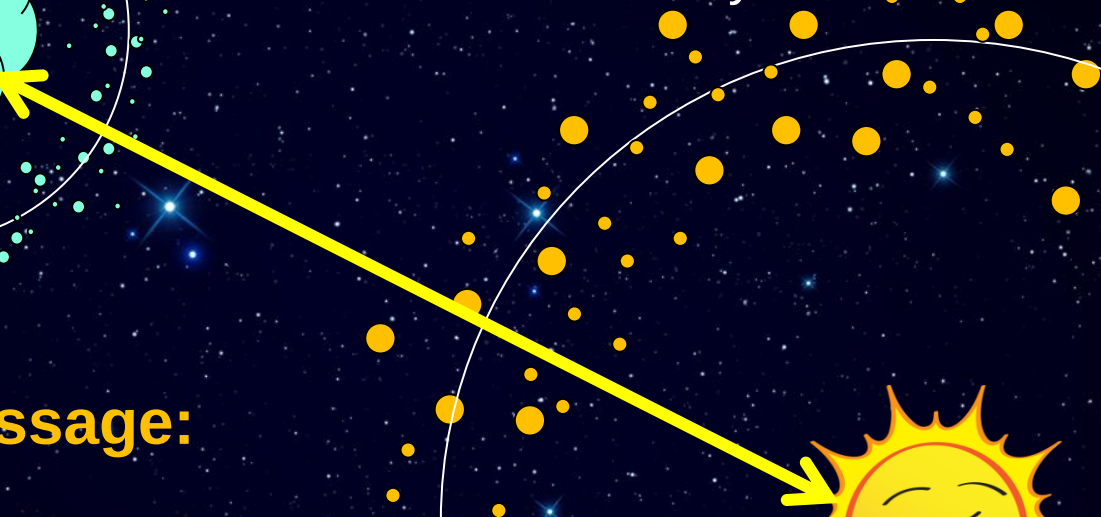
GCs BH 140 (dR = 9 pc), NGC 7078 (dR = 10 pc) UKS 1 (dR = 19 pc) and Djorg 1 (dR = 17 pc) have mean minimum relative distance values between..



Evolution of the halo and disc masses, and their characteristic scales for 411321 TVP.

Initial conditions for M 15 dynamical system:

Mass = $9.2 \times 10^5\ M_\odot$ Number of stars = 1 603 165
Radius of half-mass = 2.0 pc
Concentration (King profile) W0 = 9.0
Time evolution = 7.7 Gyr in Time variable potential



Close passage:

dR = 10 pc,
T = 320 Myr ago

N_{Oort} = 50 000 clouds

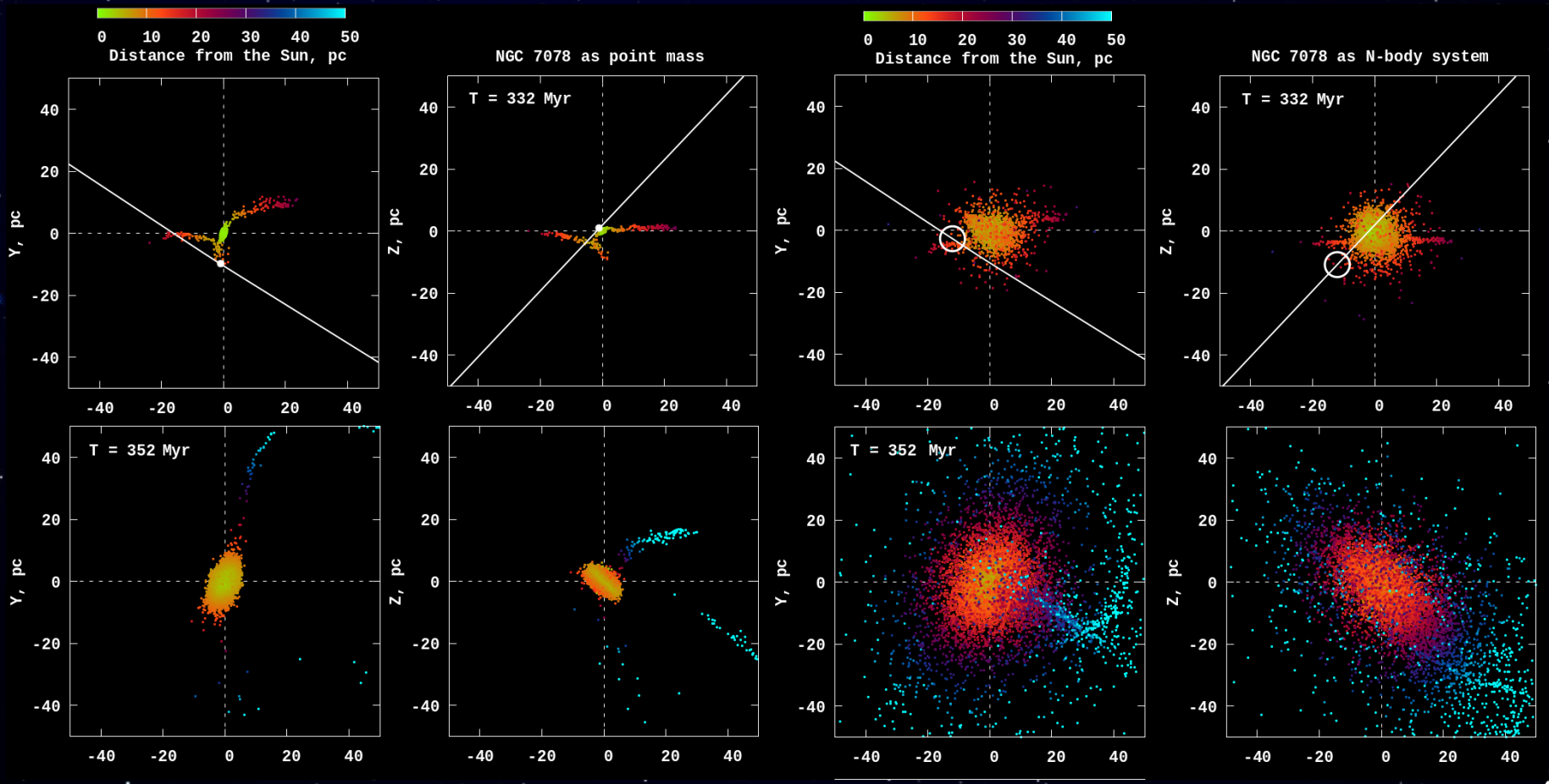
Current NGC 7078:

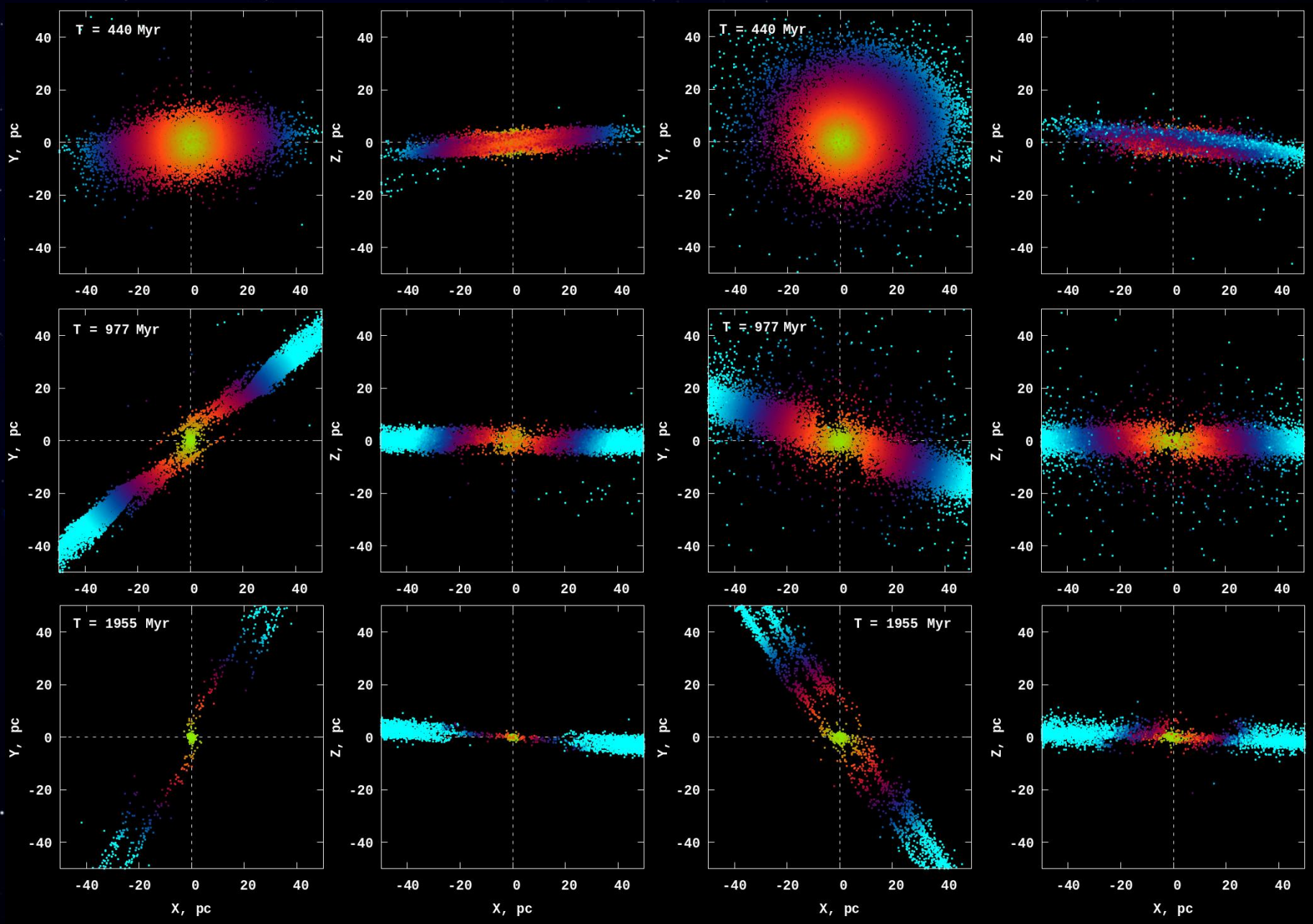
Half-mass radius ~4 pc
Mass ~ $5 \times 10^5\ M_\odot$

Oort particle distribution due to the gravitational influence of the 7078 GC flyby.

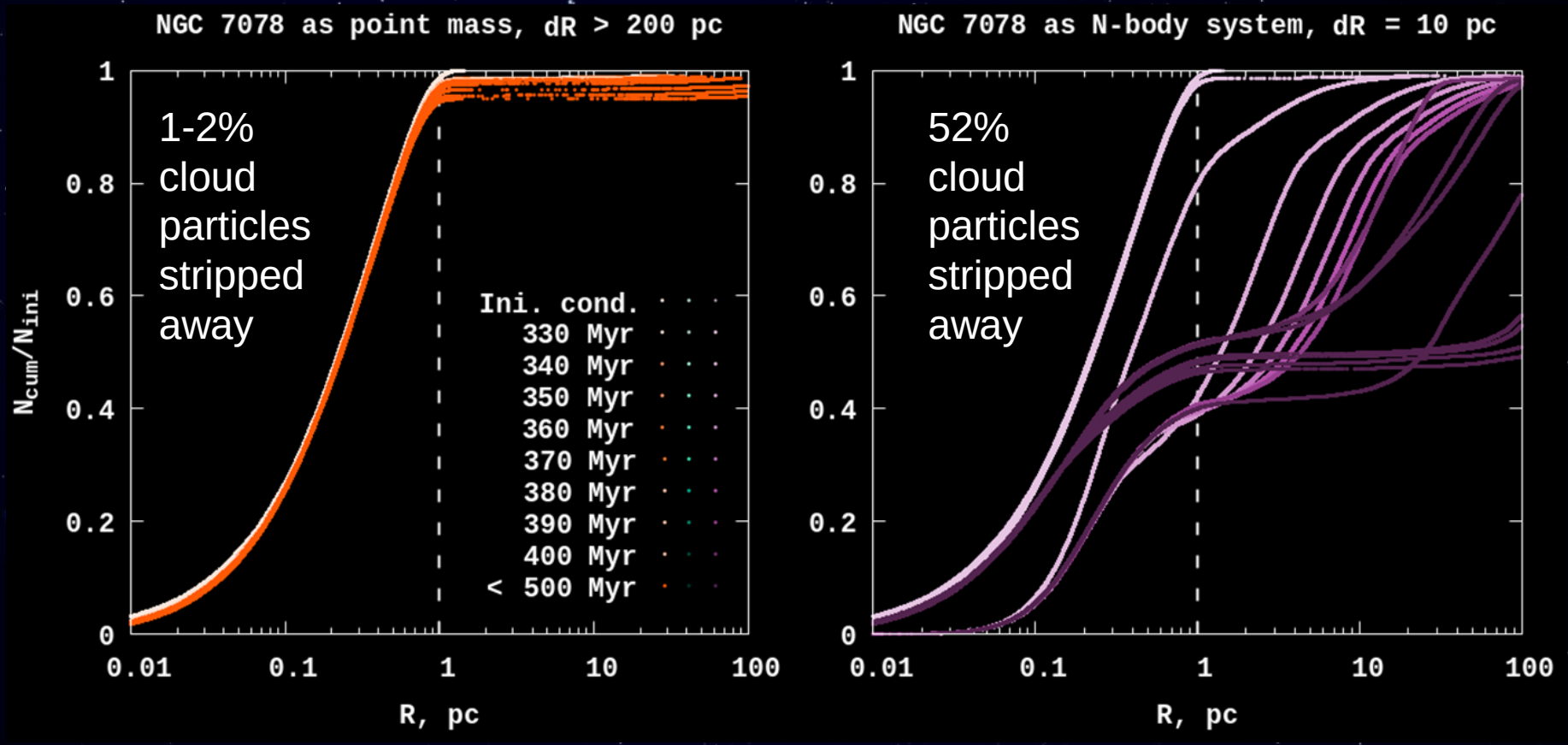
Two left-hand panels show the evolution of the Oort system due to the GC flyby as one physical particle.

Two right-hand panels show the evolution of the Oort system due to the GC flyby as an N-body system.




T = 440 Myr
T = 440 Myr
T = 977 Myr
T = 977 Myr
T = 1955 Myr
T = 1955 Myr
Y, pc
Z, pc
X, pc
40
20
0
-20
-40

Cumulative normalised Oort particle distributions at different times as a function of relative distance from the Sun.



The left panel shows the particle distributions when NGC 7078 is integrated as a single physical point mass, with passages of more than 200 pc. The right panel shows the same, but with NGC 7078 integrated as an N-body system. The dashed black line represents the outer limit (1 pc) of the Oort particle distribution in the initial state.

Probable close passage of the M 15 was 320 Myr ago

- Over 52% cloud particles stripped during the M 15 close pass, compared to a 1-2% for a flyby at a large distance, > 200 pc.
- The M 15 also causes substantial expansion, with particles spreading over 50 pc from the Sun within 30 Myr after the GC's crossing. This creates a twisted and flattened cloud structure with extended outer tails.
- More than 10% stripped cloud particles spread across the Galaxy, reaching distances of up to 16 kpc from the Sun.
- More concentrate accretion of the Oort cloud particles on the Sun, ~1-2%.

There is strong evidence of a similar extra bombardment (impact flux increases by a factor of 2.6) of the inner Solar System at the end of the Paleozoic era (300 Myr ago), which was also recently reported in the paper *Mazrouei et al. (2019), Science 363.*