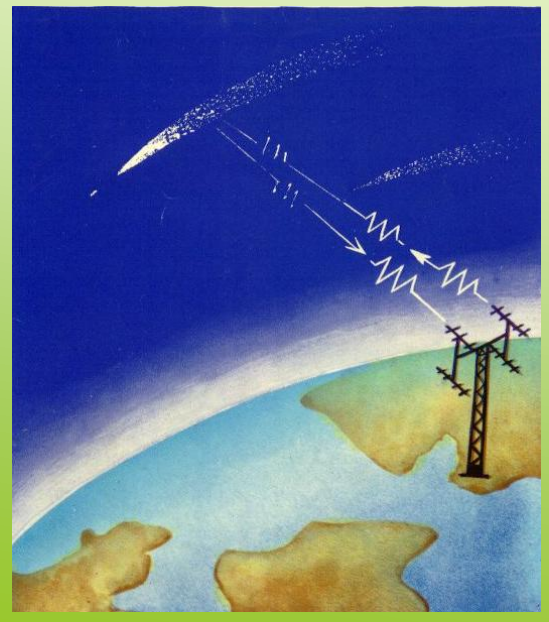


Meteor Sky in Time Domain Astronomy

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Background

Multiwavelength astronomy allows researchers to see and hear the sky above our head. But this is only part of our perception of the cosmos.

The hot handshake of the Universe in the form of meteor matter burning in the atmosphere of the Earth, sometimes with the precipitation of meteorites threatening the ecology, occurs every seconds.

The big question in meteor research now is: "How to organize observations and process existing and new data to get a response regarding the meteor time-domain astronomy?"

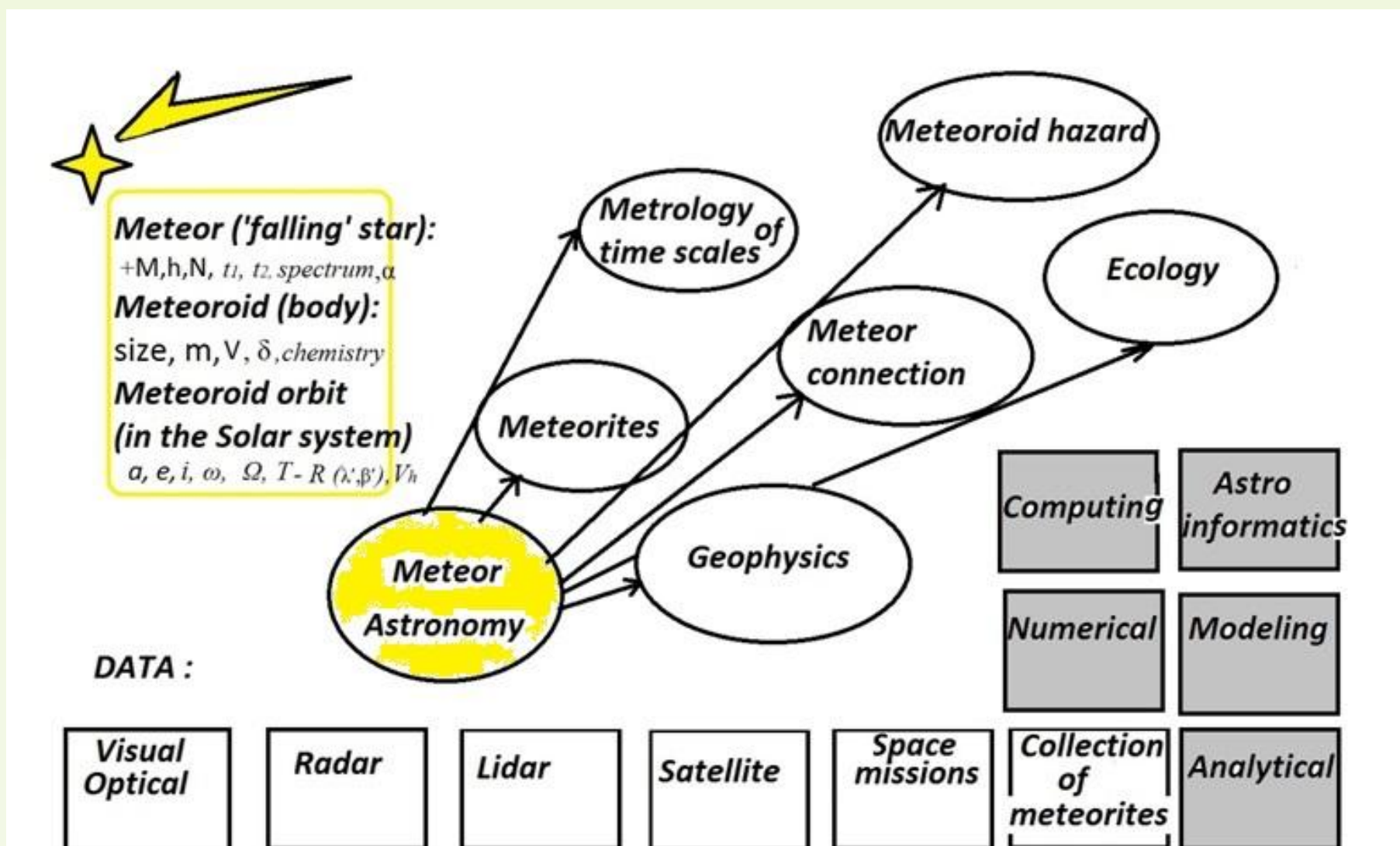
Objectives

Construction a map / maps of a meteor sky in the time domain for scientific and applied problems on the basis of the existing database of meteoroid orbits using IT technologies . The preparatory stage.

• Step 1 Research of the meteor database of the Kharkiv National University of Radio Electronics (KhNURE MBD) with ~ 250,000 meteor orbits obtained in 1972-1978 by classical meteor radar.

• Step 2 Select meteor parameters and meteor sky models

• Step 3 Visualization of the distribution of meteor orbits in systems of celestial coordinates (models in a plane)



Methods

Research method: IT technology (with statistical processing inclusive) in data processing and the electronic database * 'KhNURE MBD' applied as a research tool containing the properties of the meteor complex, in particular from the point of view of evolution. There were selected orbital parameters, inclination i , eccentricity e and aphelion distance Q . In the absence of an aphelion distance for hyperbolas, the radius vector of the second node R_0 was used in the presence of two nodes. One of the nodes of the meteoroid's orbit is always the meteoroid's point of contact with the Earth.

* the electronic database 'KhNURE MBD' is a catalog of radiant and orbits in the digital format of the results of radar observations of meteors in 1972-1978 in Kharkiv using the MARS radar (Meteor Automated Radar System, 31.1 MHz)

The creation of the software product (Meteor map) is based on the use of the Microsoft Visual Studio 2013 development environment, Windows Forms, the .NET Framework 4.5 platform, the C# programming language [3]

The construction of meteor maps and graphs in a non-spherical format (rectangular or square) was performed using the open software product STATISTICA.

Skills: Scientists of the KhNURE have an experience of equatorial radar observation of meteors up to 8 m during the African expedition to Somalia to Mogadishu (2 N, 45 E). These observations were carried during 1968-1970 on a special complex of equipment "Tropic" with frequency of radiation of 36,7 MHz. There are published 6,000 orbits.

Near Kharkiv there is the Meteor Automated Radar System (MARS) of KhNURE, which currently can not work in full and the registration of meteors temporarily does not. There is a need for its modernization.

In the KhNURE there is the knowledge base (publications, reports, etc.) on meteor radar studies of the period 1957-2017

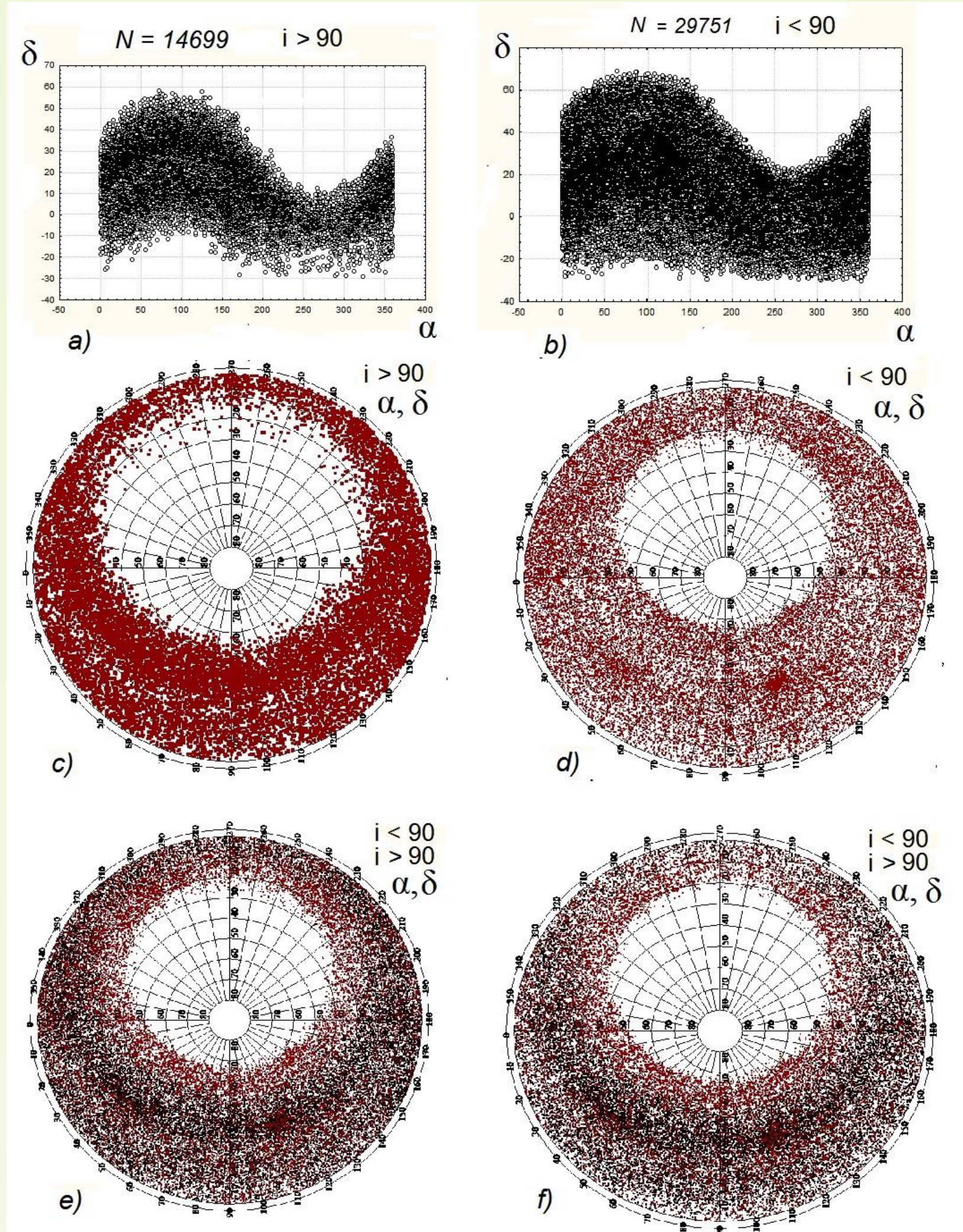
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Results

High-eccentric orbits with $e (0.5-1.0)$ and $e > 1$ can flow into the Earth's atmosphere from the outermost regions of the Solar system and even interstellar space. The Table shows a fragment of the orbit catalog. The Figure (α, δ) [3] demonstrates the behavior of two samples of meteoroids (with forward and reverse motion) with aphelions of orbits located in the space of Earth-Ceres orbits (ie from the region of the Near Earth asteroids). e, f) for black - $i > 90^\circ$

H:M	Vg σ	Vh σ	e σ	q	p	i	ω	Ω
02:09	41 ± 2.2	50 ± 1.9	1.78 ± 0.19	0.81	2.3	48	226	109
5:03	46 ± 2.4	59 ± 2.6	2.91 ± 0.34	0.96	3.7	49	157	109

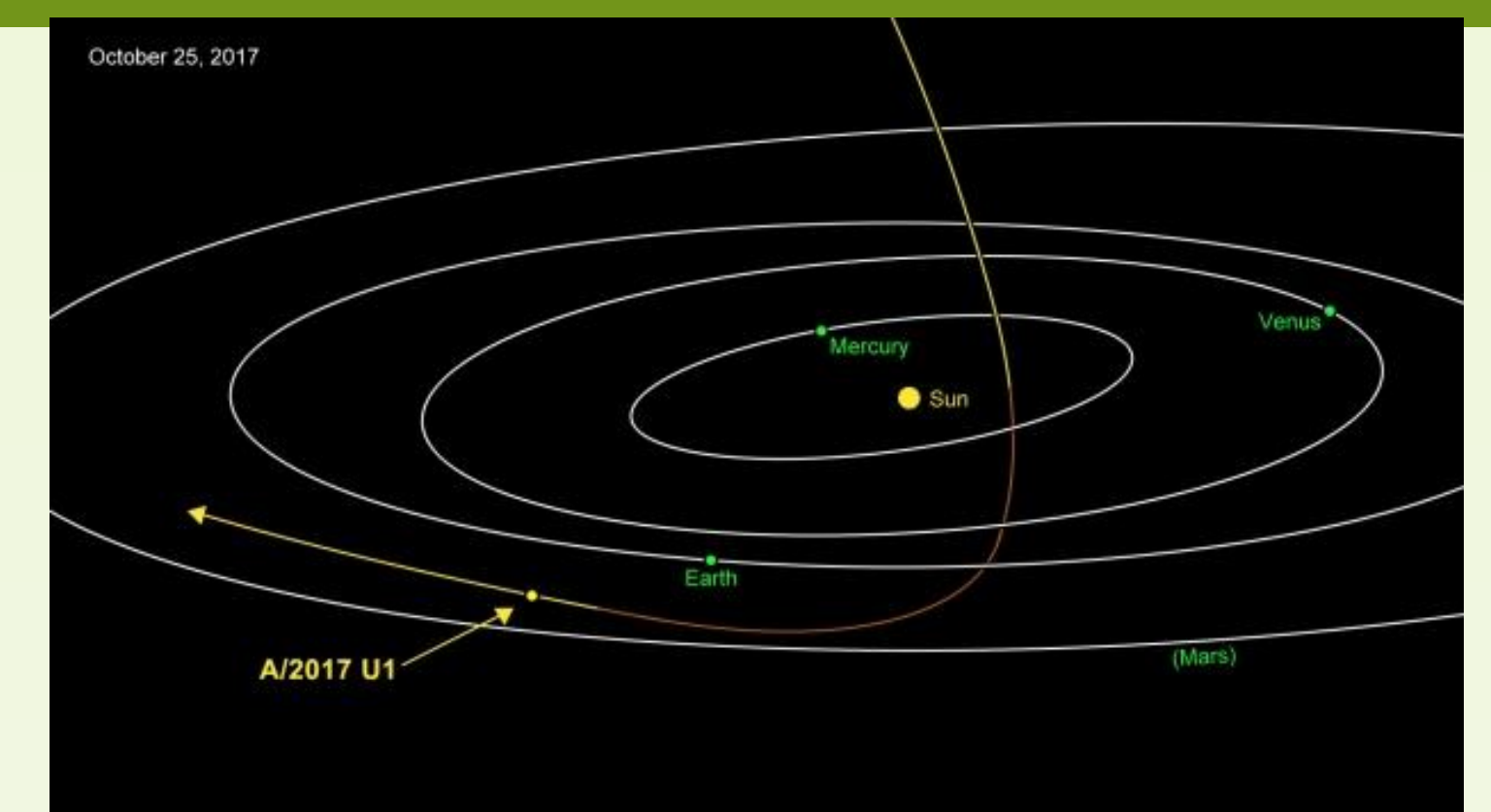


Conclusion

In astronomy, meteor observational information associated with the celestial sphere and with the observer at its center is specific. The initial definition of a meteor as a 'falling' star reflects the transient dynamic process of meteor skies.

- The aphelion distances of orbits of meteoroids from the KhNURE MBD have values within 1 - 2,000 AU, if $e < 1$.
- Undoubtedly, the meteor matter contains key information about the formation and development of planetary systems.
- Meteoroid orbits of the Near Earth space are an important tool for the research of the Asteroid-Comet dangers.
- Part of meteoroids (1%) moves along hyperbolic orbits. If the hyperbolas are real then the "height" of the meteor sky reaches the stars.
- It would be important to adapt known modern observational systems involved in deep space studies (LSST, SKA etc.) for the meteor research and continue classical studies.

News: hyperbole exists!



The object — which initially some believed to be a comet, but is now believed to be an asteroid — was discovered on Oct. 19 by Canadian Robert Weryk at the University of Hawaii Institute for Astronomy. He was going through data from the Pan-STARRS survey, a project that scans the sky for near-Earth objects. Approaching from above, the object A/2017 U1 was closest to the Sun on Sept. 9. Travelling at 44 kilometres per second, it is headed away from the Earth and sun on its way out of the solar system. (Credit: NASA/JPL-Caltech)

Discussion

Where are meteors from? What is the height of the meteor heavens? How many kinds of meteor skies are there? What is the difference between the observed sky and the true? What is the relationship between meteors, comets and asteroids? How the orbit of a meteoroids is related to a meteor sky? What is a meteor sky and how to visualize it?

The sample of the MARS primary registration (radiometer)

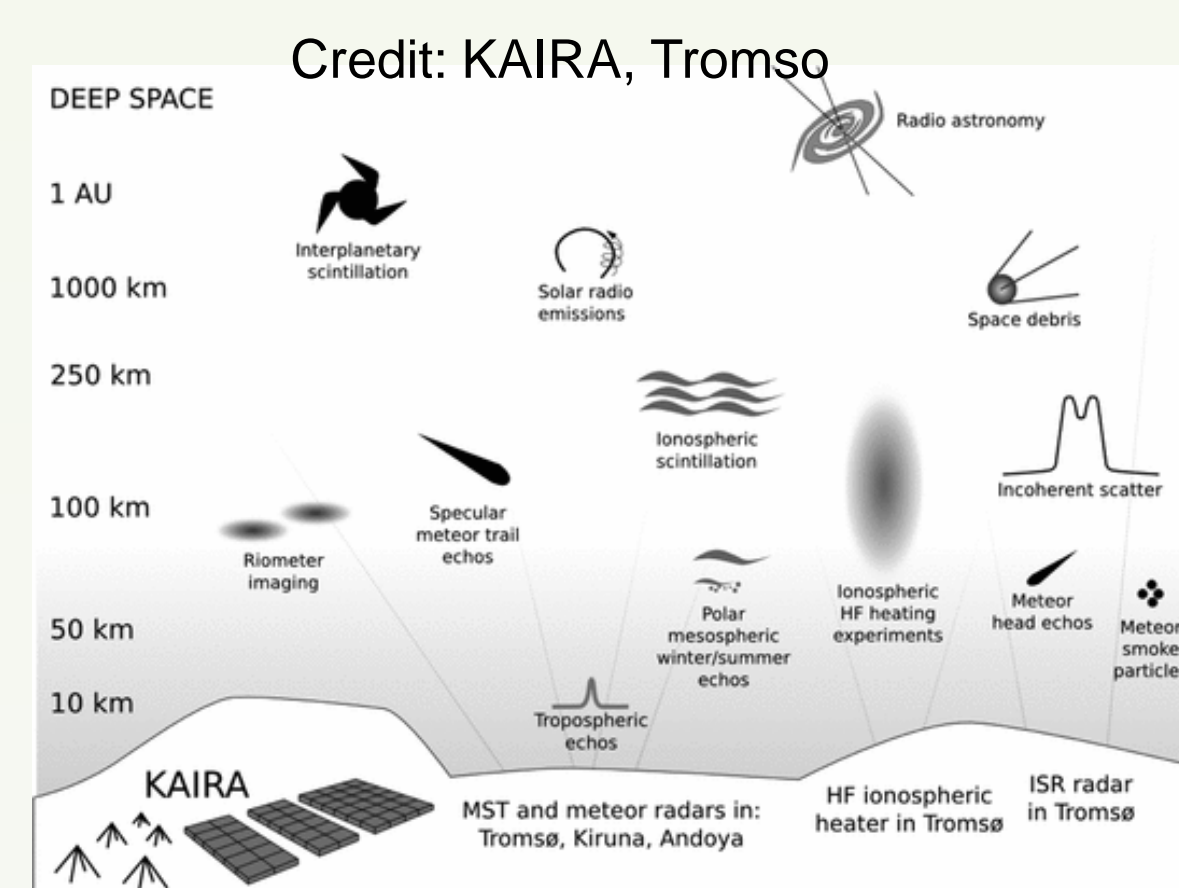
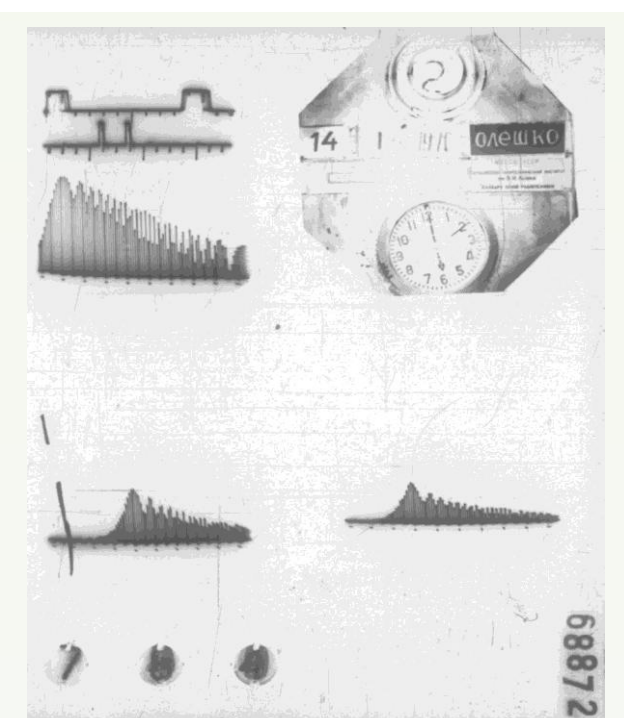
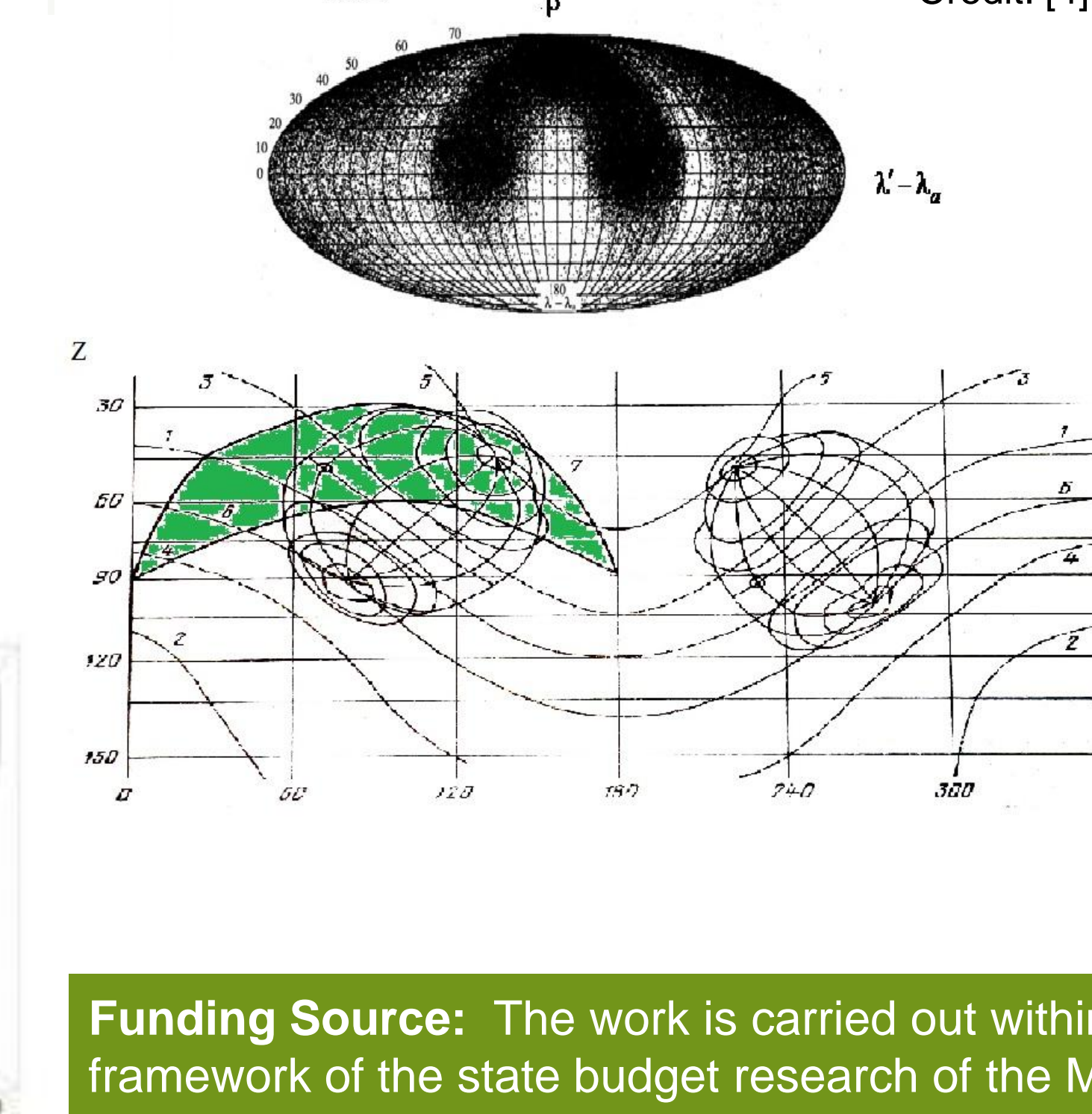
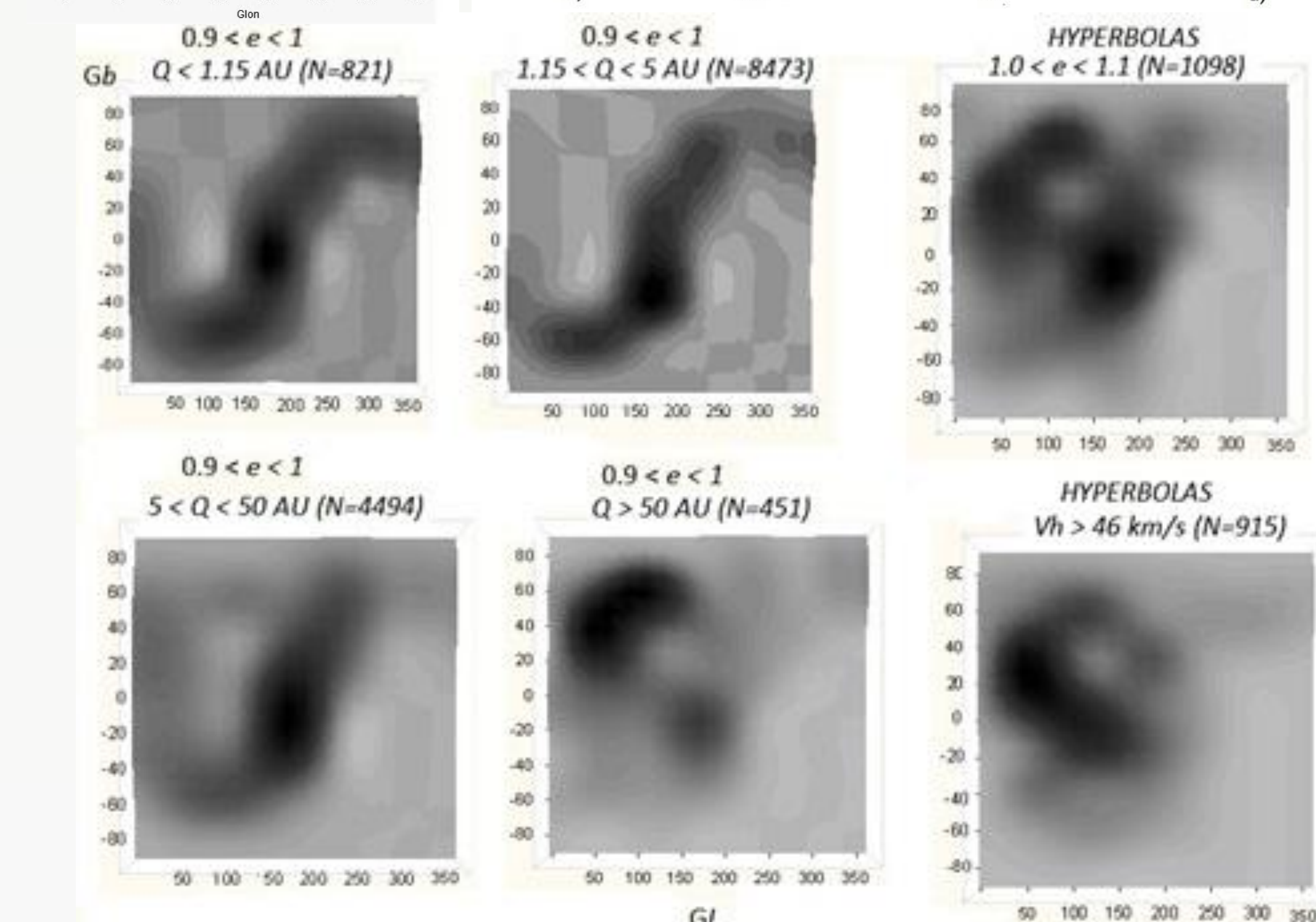
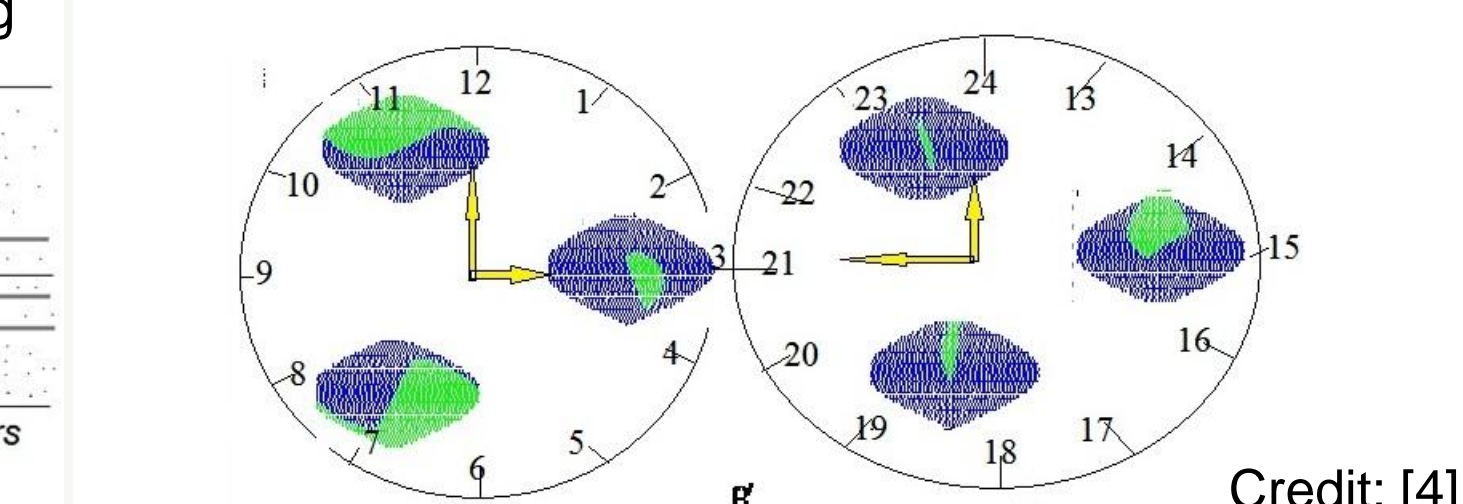
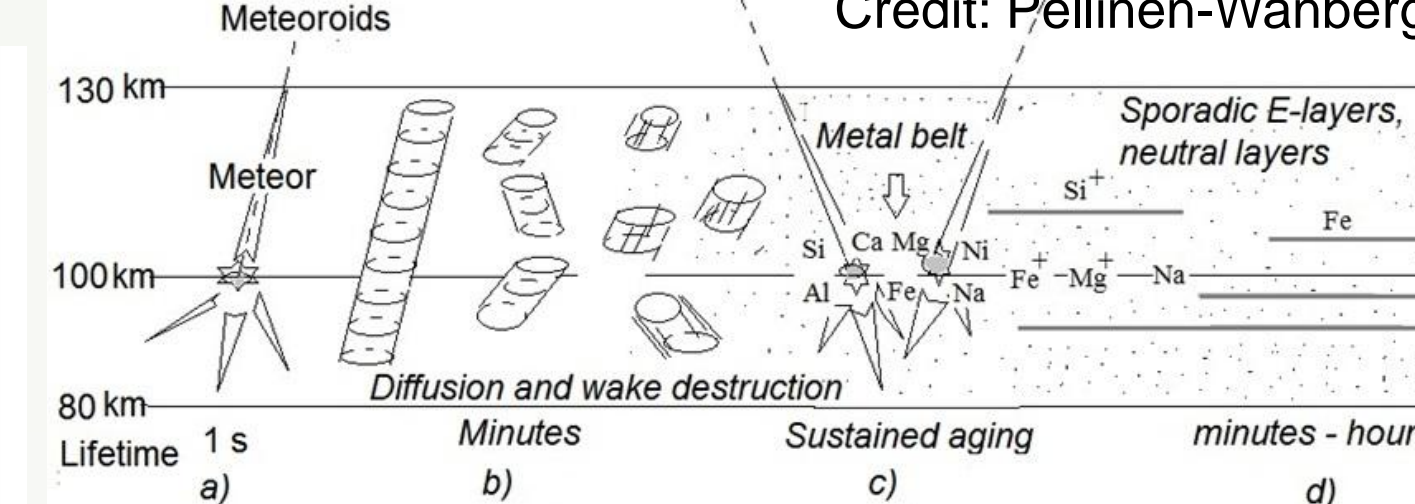
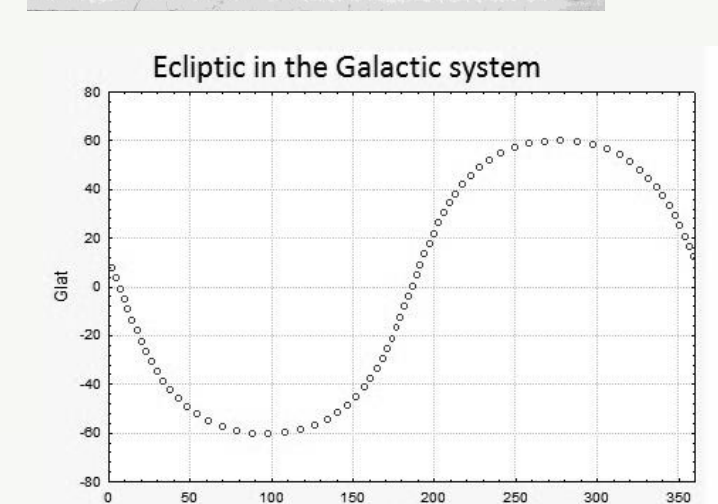
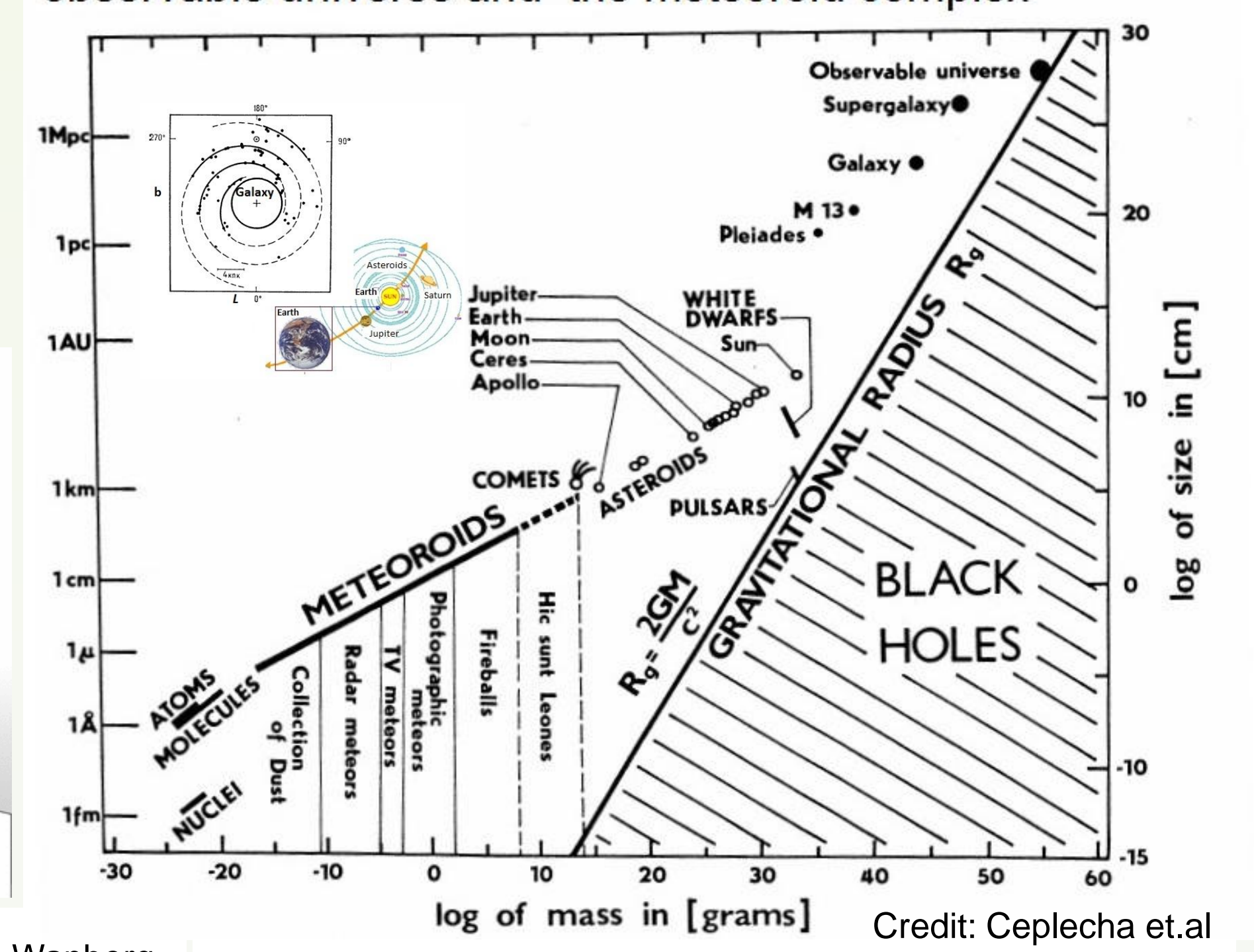


Diagram of size versus mass contains some known of the observable universe and the meteoroid complex



Funding Source: The work is carried out within the framework of the state budget research of the Ministry of Education and Science of Ukraine