

## Orbit Determination of Meteoroids by MU Radar Meteor Head Echo Observations

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The various mass ranges of meteoroids ranging between 10-15 and 1015g are continuously colliding with the Earth. Most of them are so called micrometeoroids, micrometeorites or IDPs (Interplanetary Dust Particles) whose diameters are estimated between 10 and several 100 micrometres. It is indicated by radar, high-flying aircraft and zodiacal cloud observations that a daily mass influx of meteoroids is ranging from 100 to 300 tones. However, it is still a matter of finding parent bodies of most meteoroids, while parent bodies for the most of major meteor showers have been identified as comets or dormant comets. Their physical and chemical aspects such as composition, structure as well as their origins are also poorly known. The influx rate of interplanetary dusts and artificial space debris onto the Earth's surface are essential for the human space activities. Thus, it is very important to investigate influx, orbits and mechanical strength of meteoroids that can be observed as meteors after interacting with the upper atmosphere.

High power large aperture (HPLA) radar observation is a recent technique to provide useful information on meteor influx and orbits, as well as interactions with the atmosphere. The recent development of the technique carried out using the middle and upper atmosphere radar (MU radar) of Kyoto University at Shigaraki (34.9N, 136.1S), which is large atmospheric VHF radar with 46.5 MHz frequency, 1 MW output transmission power and 8330 m<sup>2</sup> aperture array antenna, has established very precise orbital determination from meteor head echoes. More than 150,000 meteor orbits have been measured since 2009.

In this study, we present the physical quantities of meteoroids such as orbital parameters, flux rate and ablation characteristics obtained from the MU radar meteor head echo observations. The origin and internal structure of meteoroids compared with comets, asteroids and space debris will be discussed.

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