Activity Report of the NAOJ Visiting Scholar Program

Host Project/Division: Public Relation Center Name of Host Scientist: Dr. Junichi Watanabe

Name of Visiting Scholar: Dr. Pavlo Kozak

Title: Visiting Associate Professor

Period: from 2015/05/12 to 2015/07/10, and from 2015//07/21 to 2015/09/19

I. Report from the visiting scholar

[i] Achievement during the period of stay (in comparison with the initial plan)

(Collaborative Research)

According to the plan for the project "Investigation of anomalous meteors obtained with super-isocon TV systems" we had to carry out new complete review and reprocessing of meteor images with meteor anomalies; separate naturally anomalous meteors from artifacts; select some of the most interesting real anomalous phenomena; give qualitative and, if possible, quantitative explanations of them and carry out theoretical modeling.

For analysis of observational data containing meteors with some anomalies (abnormal heights of meteor beginnings, extremely hyperbolic meteor orbits, depressions in meteor light-curves, blinking meteors, nebula-like large meteor structure at its beginning etc.) we have used results of TV double-station meteor observations obtained at Astronomical Observatory of Kyiv Taras Shevchenko National University with the use of ultra-sensitive isocon TV systems. We selected series of observations of sporadic meteors carried out during time period around Autumn equinox in September 2001 and 2003, results of Leonid meteor storm observation in 2002, and Perseid shower observations in 1991-1993. Analyzing all meteors with anomalies we decided to concentrate our main forces on examination of a unique sporadic meteor from 2003 which demonstrated the increase of its altitude, i.e. it was a grazing meteor, being at the same time very faint (it is known a few cases of bright grazing bolides described in scientific publications, which went through the atmosphere and moved farer to the space). Also the meteors with high beginning altitudes (more than 130 km) were selected as another task for our investigations.

In accordance with the plan the following researches were done during four month visit:

- Software for increasing precision of measurements in meteor TV/Video frames were developed (as enhancement of the used and developed earlier base program "Falling Star"). These additional procedures include enhancement of measurements using both add/even fields of video frames from each observational point; improvement of selection of a meteor head in TV frames for increasing astrometric precision; using Monte-Carlo method for determination of statistically grounded errors of meteor kinematic parameter calculations.

- We have completely reprocessed 12 meteors with the new enhanced software (1 meteor from Perseid 1993 shower, 3 sporadic meteors from September 2001, 1 sporadic meteor from September 2003, and 7 meteors from Leonid 2002 shower) in the frame of examination of a problem of meteors with anomalous beginning heights, and 11 sporadic meteors from September 2001 and 2003 observations in the frame of investigation of a meteor with increasing altitude.

- The following meteors were selected for the examination: 8 meteors with anomalous beginning heights and 1 meteor with increasing altitude (another one was close to grazing type and had zenith distance of radiant near 90 degrees: 87 degrees).

- After detailed reprocessing we calculated parameters of trajectory in the atmosphere for the grazing meteor and its heliocentric orbital elements before and after encounter of the meteoroid with the Earth. The vector method was developed for calculation of velocity geocentric vector of the particle before and after perigee using an approach developed earlier for heliocentric orbit calculation and realized in "Falling Star".

- In addition to trajectory parameters, for additional check, we reconstruct completely 3-D trajectory of the meteoroid during its moving through the view-fields of frames, including geometry of horizontal sections of view-fields of both cameras, and their projection to the real earth map. The strict astrometric procedure was used for calculation of the view-field corners.

- The method for photometry for isocon TV system was developed, calibration was done by Vega spectrum, calibration constant was calculated. Light curve of the meteor was plotted along visible trajectory.

- Basing on photometry results we calculated the intensity of meteor radiation and its mass loss during visible trajectory.

- In order to estimate the initial mass of the meteoroid from the small part of its light curve we developed a physical model for the meteor motion in the atmosphere for the conditions of high altitude and grazing trajectory basing on a model of the "liquid drop".

- This model was used also for numerical modeling of hypothetic meteoroids of different masses, velocities and perigee altitudes for near-grazing zenith distances of meteor radiants in order to estimate the probability of grazing meteor registration by sensitive video cameras.

- Estimated probability was compared with our original observational results distributions, and other optical observations. The conclusion that the grazing meteor must be detected much more often than they are was made.

- After complete recalculation of meteors with abnormal beginning heights we leaved in the list 8 meteors from 12.

- Basing on the done work we prepare the article about the grazing meteors (paper is on the stage of text writing of the article) and partly (60 per cent) finalized the paper about meteors with anomalous beginning heights.

(Education)

(Others)

Participation in meeting of the Nippon Meteor Society in Makuhari, Chiba on 22 August 2015 during which the consultations about observational video cameras used by amateurs were carried out. This information may be

used in future for common observations, development of methods for the meteor observational data processing and according software.

[ii] Any comments on this program

The program is organized very well, there is a possibility to do theoretical investigations and numerical calculations, to take part in scientific seminars, to have consultations with colleagues, to have an excess to prepaid international journals, the working atmosphere is ideal.

[iii] List of publications and presentations by the visiting scholar in collaboration with NAOJ staff or graduate students

During visits we made two common reports on seminars of Minor Bodies of the Solar System of NAOJ:

1) "Classification of anomalous meteors from results of TV observations in Kyiv" and.

2) "Anomalous meteors with abnormally high beginning altitudes",

a report on NAOJ colloquium

3) "Anomalous meteors and modern status of astronomy in Ukraine".

Also we prepared for publication article with preliminary* title

4) "A low-light meteor moving upward" by P.Kozak and J.Watanabe

and the paper prepared in 60 per cent with preliminary* title "Low-light meteors with abnormally high beginning altitudes from TV observations" by P.Kozak, J. Watanabe.

* - the titles of accepted articles may a little differ.

Ⅱ. 以下の項目について、受入教員が記入してください。

Report from the host scientist

[iv]本制度に対する意見、要望など

Any comments on this program

コザック氏は滞在中、観測のために一度、帰国したが、それ以外は三鷹において非常に集中的に解析 を行っていた。また談話会を行ったり、太陽系小天体セミナーに出席したりと、関連研究者とも交流を 積極的にはかっていた。こういった議論から、彼の独自のデータの解釈として流星発光の規則的変化が、 ビデオ信号を記録する時の何らかの電気的な問題である可能性について、判断を正しい方向に納得しつ つあることは大きな成果であった。共同研究として論文化を進めている最中であるが、本制度の趣旨を 充分に生かしたものと考える。