

# REPORT

## VISIT TO ROMANIA

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03/07 to 10/07 2022

Short summary of Share knowledges and views on the theme Brazilian meteors network EXOSS purpose of the visit: and deliver a lecture on Earth-grazing fireball's recurrence under the Europlanet Mentorship programme.

During my stay in Romania, I worked at three main topics:

- coding PYTHON and MATLAB algorithms for a specific project about numerical integration modeling for grazing meteors analyses,
- attending a workshop with an oral presentation,
- discussions about collaboration between Brazilian EXOSS project, Romanian MOROI networks, FRIPON international network and a Hungarian meteor observations project.

At each day of the week, many activities were done in order to fulfill and implement many tasks involving coding, bibliographic revision, discussions and conference attendance.

My mentor led me a study reviewing the MATLAB code for numerical integration, Backward and Forward, using a symplectic 4th order integrator to be applied to the grazing meteor case 13/10/1990 (see Borovicka and Ceplecha, 1992), and a study of integrator REBOUND PYTHON package and its application to that grazing meteor case, making runs and comparing results with the analog MATLAB script. Also, I translated the MATLAB code to PYTHON, so it was possible to improve the graphs and outputs, comparing them with REBOUND and MATLAB algorithms. So, it was possible to accelerate the integration and get better quality results.

The main goal was to test a symplectic 4th order algorithm based on Neri numerical integration (see Neri, 1987) supposed to be a fine solution for celestial bodies close encounters. In fact, Neri's approach is able to reproduce before/after orbits of the grazing meteor case, taking in account minimum distance between bodies. Those results were compared to that PYTHON package REBOUND and they both showed good agreement.

Besides, I attended to the International conference *Theory, Observations and Data Processing in Astronomy, Astrophysics, Space and Planetary Sciences*, presenting the lecture entitled: "**An earth-grazing fireball case: simulating close encounters using Rebound Python package and a 4th order Symplectic Integrator**", about meteor study topics, its physical parameters, image processing and video registering instruments, updating EXOSS project last 5 years results in Brazil, and talking about *Earth-grazing fireball of October 13, 1990* (see Borovicka and Ceplecha, 1992). In addition, discussing some preliminary results, that were produced using MATLAB and PYTHON codes, as mentioned above.

Further, we had a meeting with dr. Mirel BIRLAN, dr. Simon ANGHEL, dr. Ioana BOACA from IMCCE – France, and Astronomical Institute of Romanian Academy – Bucharest, and dr. Iharka SZUCS-CSILLIK from Astronomical Institute of Romanian Academy - Cluj-Napoca, and dr. Tibor HEGEDÚS from Baja Astronomical Observatory of Bacs-Kiskun

County, Hungary and I, for possible and future collaborations between MOROI network, Hungarian fireball's cameras, FRIPON network and EXOSS project, outlining goals, exchanging know-how, as instrumentation, cameras and software for images analyzes. It was decided to have more rounds of discussions, as it is clear that collaboration and exchange experiences could be an excellent mode to increase meteor studies in each one of the countries involved.

### **Bibliography**

Borovicka, J. and Ceplecha, Z. (1992) Earth-grazing fireball of October 13, 1990. *Astron. Astrophys.* 257,323-328.  
Neri, 1987...eri, F.: Lie algebras and canonical integration. Dept. of Physics, Univ. of Maryland, preprint (1987).  
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