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# **Proceedings of the 2002 International Science Symposium on the Leonid Meteor Storms**

*Held on May 2–5, 2002  
at the National Museum of Emerging Science and  
Innovation, Odaiba, Tokyo, Japan*

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## PREFACE

This volume is the peer-reviewed proceedings of “the 2002 International Science Symposium on the Leonid Meteor Storms” held on the 2-5th May 2002 at the National Museum of Emerging Science and Innovation (MeSci), Odaiba, Tokyo, Japan. The meeting was also the diversified version of the third series of the annual “Leonid Multi-instrument Airborne Campaign (MAC) Workshop”, which started in 1999. First held at NASA Ames Research Center, California, USA and then at Tel Aviv University of Israel in the following year, the workshop provided both ground observers and international crew of the NASA-led “Leonid MAC” mission opportunities to reunite and discuss initial results of their observations made in November of the previous year. It also polished up observation plans of the Leonids next fall.

In the past, the Leonid MAC came to Japan for three times. Dr. P. Jenniskens of the SETI Institute first proposed its concept during the 23rd IAU General Assembly at Kyoto in 1997. One year later, its successful maiden flight took place in the sky over Okinawa. In 2001, the mission was once again planned to fly the west bound of the Pacific Ocean but it ended up staying above the US soil to catch only the first peak. Thus the third return of the Leonid MAC to Japan was this very symposium.

The 2002 workshop became a “dual peak” event on both the east and west coasts of the Pacific Ocean, just like the Leonid meteor storms in 2001. On the 13th April, one-day business meeting was held at NASA Ames and 17 presentations were made by American researchers and aircraft operators in order to discuss their on-going research and flight plans for the 2002 mission. Two weeks later, the Japanese local organizing committee (LOC) hosted this three-day science symposium in the Tokyo Bay Area and opened it to a wider community of professional researchers, amateur astronomers, media reporters and high school students. The Tokyo symposium attracted more than 120 registered participants from 10 countries and about 70 oral and poster presentations, followed by a bus tour to visit three national space institutes (ISAS, NAOJ, and NAL), a public lecture at MeSci, and a press conference. This symposium turned out to be the World’s largest science meeting dedicated to the Leonid meteor research in our time. In this volume, research papers reflecting results of about a half of these 70 presentations were accepted for inclusion.

Japan has a long tradition of meteor observation since the first millennium. According to Prof. I. Hasegawa, Japanese, wrote the first historic record of the later-known-to-be Leonid meteor shower on the 14th October in 967 A.D., just 44 days after the parent comet Tempel-Tuttle’s closest approach to the Earth. Since then, shooting stars have become popular motif of literatures and folklores in Japan over 1000 years and still fascinate many amateurs at all ages. Thanks to modern digital imaging technology, it is also true that this round of the Leonids has become the most imaged meteor storms in the history of humankind. And it is no doubt that the majority of such images were taken by Japanese amateurs, at least in the case of the 2001 storm. Thus this symposium was an excellent opportunity to demonstrate the world how much Japanese amateurs and school students dedicated themselves to meteor observation and how scientifically sound they were. In this volume, the LOC encouraged and helped them to publish their results through the same review processes as professionals.

The Leonid meteor storm investigations from space to ground are namely “cometary exploration without sending a spacecraft”. Indeed, the Leonid meteor storms in 1998–2002 were an astronomical opportunity of “once in a Century” and they have literally revolutionized the meteor science by observing in UV, visible, IR to radio waves, and by world-wide radar campaigns to airborne multi-instrument/ multi-wavelength missions. This somewhat resembles with the case of the “International Halley Watch” spacecraft armada in 1980’s, which revolutionized the cometary science. For examples, cross section of the dust trail of the parent comet was optically imaged and inhomogeneous structures within the dust tube was modeled and confirmed by observations so that the peak times could be

forecasted in the accuracy of minutes. Scientists have also better understood impact hazards to operational satellites, meteoroid impact origin of lunar transient phenomenon, nature of ultra high altitude meteors above 130 km, light curve variety, clustering and jetting of individual cometary meteoroids suggesting their “dust ball” structure, formation of shock-like front in bright fireballs, aero-chemical processes to produce persistent trains, and spectral signatures of volatile components implying meteors as extraterrestrial organic carriers to the Mother Earth. These were all newly exploited within this revolution of the Comet Tempel-Tuttle. We hope that this volume will serve as one of key reference books for such new advancements of the meteor studies, for years to come.

The symposium site MeSci is one of the newest and largest science museums in Japan and has been directed by Astronaut Dr. M. Mohri since 2001. The LOC was the most grateful to receive full support from MeSci staffs in the whole process of the symposium. In return, we offered free open lectures, which attracted more than 100 public audiences on the final day. This was a new type of collaboration between researchers and a museum and such an outreach exchange may well become a future trend of science education. We also sincerely thank all the presenters and participants of the symposium for having inspiring science discussions, many anonymous referees for evaluating papers in this volume, secretaries of our laboratories for supporting logistics of both the symposium and proceedings editorials, and all the symposium volunteers for making such a large event so successful in a very limited time of preparation.

At last but not the least, we are proud to have received a large number of invaluable sponsorships, without which we could have never made this event possible. Our main sponsors were the Institute of Space and Astronautical Science (ISAS) and the National Museum of Emerging Science and Innovation (MeSci), while co-sponsors include the National Astronomical Observatory of Japan (NAOJ), the Nippon Meteor Society (NMS), Kyoto University-Radio Science Center for Space and Atmosphere (RASC), the SETI Institute, and NASA Ames Research Center (NASA/ARC). The Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT) also provided the International Symposium Grant to invite overseas scientists and the Society for promotion of Space Science partially supported publication of the proceedings. We also wish to extend our gratitude to Tokyo Press Publishers, Page Enterprises, Inc., ISAS Publication Division and Prof. A. Fujiwara of ISAS who closely and patiently worked with the LOC during a long, complicated editorial processes.

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