International and Japanese Activities of Satellite Laser Ranging for Global Geodesy

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For more than 50 years, the Satellite Laser Ranging (SLR) technique has played a key role in geodesy and orbital dynamics. SLR data have been used continuously to to study the dynamic Earth, the Earth-Moon system, and fundamental constants, and to provide a better understanding of our global environment.

In cooperation with the IAG’ s (International Association of Geodesy) Global Geodetic Observing System (GGOS), space and ground based techniques are working together to develop and improve data products that rely on their combination of strengths and unique capabilities. A good example is Terrestrial Reference Frame (TRF), which is the basis for our metric measurements of global change, including the detection and monitoring of small global-scale signals. The TRF is a product of the combination of SLR with GNSS (Global Satellite Navigation System), VLBI (Very Long Baseline Interferometry) and DORIS (Doppler Orbitography and Radiopositioning Integrated by Satellite) combined into a product of accurate fiducial station positions and velocities. SLR uniquely provides the reference frame origin and with VLBI, its scale. Laser ranging is also now an emerging tool for accurate time transfer between clock in the Earth and in space.

One great strength of SLR lies in the use of optical wavelengths. It can yield a high-precision, unambiguous two-way distance between a ground station and a satellite, and its measurement is not affected by ionosphere and less affected by troposphere. SLR systems are operating at sub-centimeter precision. Newer technologies, already implemented at some of the stations, are approaching 1 mm precision.

The number of SLR targets is increasing rapidly. In addition to the spherical geodetic satellites, laser reflectors are being carried on altimetry, gravimetry, Earth observation, navigation, and space engineering satellites. The ILRS presently tracks about 90 satellites.

Since the late 1960s when Tokyo Astronomical Observatory (current National Astronomical Observatory of Japan) tested SLR at Dodaira, Japanese stations have participated in the international SLR community. Three SLR stations, Shimosato, Koganei and Tanegashima, are being operated in Japan. In addition, JAXA (Japan Aerospace Exploration Agency) has launched a number of SLR satellites including the 30-year-old Ajisai satellite, which is still being tracked for orbit dynamics and Earth science. The Japanese SLR community and space geodesy community hope to explore new challenges in SLR observations, data analysis and satellite missions so as to effectively yield the global-scale geodetic products in cooperation with International Laser Ranging Service.

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