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Satellite Geodesy viewed from the perspective of Celestial Mechanics (Vening Meinesz Medal Lecture)

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It is rather common to view Celestial Mechanics as a tool, but not as a scientific issue in satellite geodesy. This attitude is probably caused by two circumstances: (1) the orbits of artificial Earth satellites (or of other celestial objects) are not considered scientifically important "per se". (2) For many applications it is possible to separate the orbit determination problem from the derivation of the parameters of interest to the broader scientific community. The success of the IGS is a living proof for the latter statement.

In this lecture we argue that Celestial Mechanics, properly understood, is the central mathematical and scientific issue in modern geodesy. This view is supported by the fact that not only the satellites (GNSS or LEO), but also the observers on the surface of the Earth are in essence on trajectories dictated by the laws underlying Celestial Mechanics: the former approximately solve the equations of motion of a point mass orbiting the Earth, the latter (approximately, as well) the Euler-Liouville equations of planetary rotation.

We first review the impressive achievements, but also the remaining problems of the practice-driven approach in the recent past. We then develop the Celestial Mechanics understanding of parameter estimation in the new era of geodesy using the above indicated fundamentalist view. As the "separation of problems" proved to be very fruitful when dealing with (presumably) purely geometrical aspects we also offer the Celestial Mechanics' understanding of simplified approaches to solve the general problem.

The new era of geodesy, which is based on the three pillars "geometry", "Earth rotation", and "gravity", also asks for an adjustment of the international collaboration in the field of geodesy. The aspect is briefly addressed, as well.