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GRAIL gravity field determination using the Celestial Mechanics Approach - status report

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The NASA mission GRAIL (Gravity Recovery And Interior Laboratory) inherits its concept from the GRACE (Gravity Recovery And Climate Experiment) mission to determine the gravity field of the Moon. The use of inter-satellite Ka-band range-rate (KBRR) observations enables data aquisition even when the spacecraft are not tracked from the Earth. The data allows for a highly accurate estimation of the lunar gravity field on both sides of the Moon, which is crucial to improve the understanding of its internal structure and thermal evolution. In this presentation we discuss GRAIL-based lunar gravity fields generated with the Celestial Mechanics Approach using the Bernese Software. Currently, KBRR observations and position data (GNI1B products) are used to solve for the lunar gravity field parameters in a generalized orbit determination problem. Apart from normalized spherical harmonic coefficients up to degree n = 200, also arc-specific parameters like initial state vectors and appropriately spaced empirical parameters (pseudo-stochastic pulses and empirical accelerations) are set up as common parameters for all measurement types. The latter shall compensate for imperfect models of non-gravitational forces. In this respect, we present our advances towards a more realistic model of solar radiation pressure using empirical accelerations in appropriate directions. We compare our results from the nominal and from the extended mission phase with the most recent lunar gravity field models released by other groups, as well as their consistency with topography-induced gravity. We show that the lunar gravity field can be recovered with a high quality by adapting the Celestial Mechanics Approach, even when using pre-GRAIL or pre-SELENE gravity field models as a priori fields. As a further extension of our processing, the GNI1B positions are replaced by the original Doppler observations of the Deep Space Network (DSN) to allow for a completely independent determination of the lunar gravity field using the Celestial Mechanics Approach and we present the currently achieved status of the DSN data modeling in the Bernese Software.