High Degree and Order Gravity Fields of the Moon Derived from GRAIL Data

F.G. Lemoine (1), S.J. Goossens (2,1), T.J. Sabaka (1), J.B. Nicholas (3,1), E. Mazarico (4,1), D. D. Rowlands (1), B.D. Loomis (5,1), D. S. Chinn (5,1), D.S. Caprette (5,1), J. J. McCarthy (5,1), G. A. Neumann (1), M.T. Zuber (4), D.E. Smith (4,1)

The Gravity Recovery and Interior Laboratory (GRAIL) spacecraft conducted the mapping of the gravity field of the Moon from March 1, 2012 to May 29, 2012. The twin spacecraft acquired highly precise K Band range-rate (KBRR) intersatellite ranging data and Deep Space Network (DSN) data during this prime mission phase from altitudes of 15 to 75 km above the lunar surface over three lunar months. We have processed these data using the NASA GSFC GEODYN orbit determination and geodetic parameter estimation program, and we have determined gravity fields up to degree and order 420 in spherical harmonics. The new gravity solutions show improved correlations with LOLA-derived topography to high degree and order and resolve many lunar features in the geopotential with a resolution of less than 30 km, including for example the central peak of the crater Tycho. We discuss the methodology used for the processing of the GRAIL data, the quality of the orbit determination on the GRAIL satellites and the derivation of the solutions, and their evaluation with independent data, including Lunar Prospector. We show that with these new GRAIL gravity solutions, we can now fit the low altitude, extended mission Lunar Prospector tracking data better than with any previous gravity model that included the LP data.