The Science Case for the Ganymede Laser Altimeter (GALA) on ESA's Jupiter Icy Moons Explorer (JUICE)

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The Ganymede Laser Altimeter (GALA) is one of ten selected instruments for ESA's JUICE mission. Here we will give an overview on the scientific objectives for Europa, Callisto, and in particular, Ganymede to be accomplished by GALA. By obtaining range measurements during flybys at the moons and in orbit around Ganymede, geodetic and geophysical objectives will be addressed. Prime objectives at Ganymede are (1) determining the satellite's topography on global, regional, and local scales and (2) measuring tidal surface deformations. The topography measurements will provide information on the body's shape in relation to hydrostatic equilibrium. It will characterize topographic depressions and elevated regions for impact basins and other large scale features. Local topography will give insight into formation mechanisms for geologic features, e.g. the grooved terrain, cryo-volcanic sites, and impact structures. By obtaining range measurements at different tidal phases along Ganymede's orbit, the radial surface displacement can be measured. The tidal amplitudes are crucial to confirm a subsurface ocean on Ganymede. In addition the tidal phase-lag, if it can be detected, can provide key information on the deep interior of the satellite and the global dissipation inside Ganymede. Geodetic measurements will focus on the rotation state of Ganymede including the orientation of the pole and possible physical librations in longitude. By analyzing the spreading of the return pulse, the surface roughness on the scale of the laser footprint, i.e. approximately 50 m at the nominal 500-km orbit, can be determined. The slopes between individual laser spots along the track provide further information on surface roughness on larger scales, possibly correlated with geological features. The albedo at the laser wavelength of 1064 nm is obtained from each shot. Possible correlations with topographic heights and specific surface features can provide information on geological processes and on the interaction of the surface with the moon's radiation and particle environment. On Callisto, the measurements will be focused on a global shape determination to test whether this satellite which is only partially differentiated, is in a hydrostatic state. In addition impact structures of different sizes and types will be characterized by high-frequency along-track measurements. On Europa, the ground-tracks will focus on recently active sites and chaos regions. Combined with subsurface radar measurements and imaging data, this will provide insight in the formation mechanism of these unique features on Europa that are probably related to liquid water reservoirs near the subsurface. Constraints on the global shape of Europa will be provided by the flyby laser profiles with high spatial resolution. In addition surface roughness and reflectivity will be measured during the Callisto and Europa flybys.

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