Thermal evolution of the Galilean moons' embryons during their accretion phase

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The extent of differentiation within the interiors of the Galilean moons remains inadequately determined. Analysis of Callisto's moments of inertia, derived from Galileo's gravity data, suggests its structure lacks full differentiation. Furthermore, a recent reevaluation of the Galileo data casts doubt on the long-standing assumption of Europa possessing a metallic core. Our objective is to elucidate the accretion conditions necessary for the Galilean moons to develop without undergoing global melting and differentiation. To achieve this, we employ a numerical model simulating the thermal evolution of icy moon interiors throughout their accretion and post-accretion phases. Each moon's embryo undergoes various heating mechanisms, including tidal heating, radiogenic heating, accretional heating from multiple impacts, and heat from the surrounding circumplanetary disk during growth. The magnitude of each heating process is contingent upon the presumed formation trajectory of each moon within the Jovian circumplanetary disk. Consequently, we investigate optimal scenarios that account for a partially differentiated moon akin to Callisto and a fully differentiated moon resembling Ganymede. Additionally, we examine the conditions conducive to iron melting and the formation of a metallic core within Europa's context.