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Callisto, a pristine world that may preserve the earliest history of the Jovian system

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In the coming decade two Flagship missions will investigate Europa and Ganymede, two icy moons of Jupiter both believed to be fully differentiated with ice shells, an ocean beneath the ice, and (in the case of Ganymede, at least) a rock-metal deep interior. Melting and differentiation in these bodies has essentially erased the record of their initial interior states. Largely ignored is the third in the triad of Jovian icy moons, Callisto, nearly Ganymede's twin in size and mass, but not fully differentiated based on Galileo gravity data. Since differentiation is a process that once started is difficult to stop, Callisto is an enigma. And with (albeit weak) evidence that Callisto has the induced magnetic field signature of an internal ocean, its partly differentiated state is even more mysterious. Thus an incompletely differentiated Callisto is an unexpected state that would provide important constraints on how the Galilean moons formed and evolved. Further, why should adjacent moons so close in bulk properties be so different, not only in their interiors but also in their surface features? Callisto's pristine surface records the bombardment activity of the earliest solar system, showing no sign of internal activity, while Ganymede's grooved terrain bespeaks an early active tectonic history. All three ice moons were formed shortly after the birth of Jupiter and if we are to understand their formation, and the early environment in the outer solar system, we need to understand why Callisto appears so different. And so Callisto is an enigma wrapped in a mystery whose relationship to its neighbor presents a conundrum. Surely, a destination in the calling. . . .