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Iapetus: Results from the Cassini Imaging Experiment and Notes on the Brightness Dichotomy Enigma

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Cassini ISS images obtained over the past 3.5 years in orbit around Saturn provide new insights about the surface features, properties, processes and history of Iapetus, the outermost regular Saturnian moon. Particularly valuable are the non-targeted flyby on New-Year's Eve 2005 with a good view on the leading side, and the targeted flyby in September 2007 where especially the trailing side was seen in particularly fine detail.

There are many questions about Iapetus to which imaging might contribute solutions: What is the reason for the unique global brightness dichotomy that has already been discovered in 1672 by G.D. Cassini? How did the (also unique) equatorial ridge form, and what is its detailed morphology? What is the distribution of the craters and large basins on the surface, and how old is the surface? What geologic processes (besides cratering) took place on Iapetus? Why is there a very distinct patchy segregation of dark and bright material at local scales? What is the thickness of the dark blanket? Why are there no large bright craters within the dark hemisphere? What is the time scale for a fresh bright crater in the dark terrain to fade back to the darkness of the surrounding terrain [1]?

The origin of the global brightness dichotomy is one of the oldest and most intriguing problems in planetology. Cassini data give strong clues about why Iapetus has a completely dark hemisphere (albedo $\sim$5%), while the other one is very bright (albedo $\sim$50%). Our data indicate that this unique dichotomy formed and is maintained by a combination of several coincidental mechanisms: (A) Despite its long orbit period (79.3 d), Iapetus is in synchronous rotation, hence it has a leading and a trailing side.

(B) There should be a source of reddish, non-ice dusty material that deposits material on the leading side; the retrograde outer irregular moons are plausible candidates [2]. (C) Iapetus, as the outermost regular Saturnian moon, is the first known obstacle for this dust. These mechanisms are proposed to cause Iapetus' *color dichotomy* detected by the Cassini ISS camera in 2005 [3]. It should also redden and (somewhat) darken the next inner moon, Hyperion. Titan, the next satellite inward from Hyperion, could be a sink for the remaining material. (D) Due to the slow rotational period and subsequently unusually long solar exposure, the surface of Iapetus is among the warmest places in the Saturn system. (E) Due to the slight darkening (and hence warming) of the leading side by the reddish dust, the conditions for thermal segregation of water ice to act noticeably are better on the leading side than on the trailing side, but only at low and mid-latitudes. This makes the process of thermal segregation a favorable candidate for the global *brightness dichotomy* formation and persistence [4]. (F) Thermal segregation also seems to work efficiently on equatorward-facing slopes on low- and mid-latitude terrain of the trailing side, and is proposed to be the cause for the complex local-scale dark/bright pattern here [5]. Together with the determination of a power law for the fading of bright craters within the dark terrain [1], this correlation is a strong indicator that thermal segregation is not just ongoing today, but also a very plausible mechanism for the global brightness dichotomy.

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