The Nature of Titan

Titan is intermediate in mass and density to Ganymede and Callisto. One possible view is that it is in fact remarkably similar to these bodies, except that it has a dense atmosphere. Another view is that the atmosphere is intimately linked to the interior and you cannot understand one without the other. Partial evidence for the latter view comes from the recognition that Titan is continuously losing its methane reservoir:

\[ \text{CH}_4 \rightarrow \text{heavier hydrocarbons (especially C}_2\text{H}_6) + \text{H}_2 \] (escapes)

This is caused by photochemistry in the stratosphere and is equivalent to a loss \( \sim 1 \text{km} \) of a liquid methane global ocean over geologic time. This methane reservoir must somehow be supplied. The ethane falls to the surface as a liquid and could in turn produce a hydrocarbon ocean.

There is no direct evidence for such an ocean from HST images. There may be large lakes. There may also be subsurface storage (analogous to the storage of water in Earth’s crust.)

Crucial Observations for Titan

1. *Gravity Field* This will tell us the moment of inertia and thus determine whether Titan is like Ganymede (fully differentiated) or like Callisto (only partially differentiated). This can be done by the Cassini orbiter.
2. *Magnetic Field* Titan appears to be different from Ganymede (i.e., lacks a dynamo) But it may possess an induction response (lie Callisto and Cassini orbiter.
3. *Radar Mapping* (from the Cassini orbiter) This will tell us whether the surface features are dominated by impact craters or whether there are also tectonic and volcanic features. It may also tell us there are lakes of liquid hydrocarbons.
4. *Surface Measurements* by the Huygens probe could tell us there is liquid on the surface (among other things).
Triton and Pluto/Charon

These bodies may have similar structures, but again we have rather little information, except about their surfaces. The role of volatile ices would seem to be very important here. In this sense they have something in common with Titan.