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Dynamical Constraints on the Orgin of the Moon

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Dynamical studies dealing with the orgin of the Moon are described and are used to try to eliminate dynamically impossible or implausible theories of lunar orgin. The orgin of the Moon is discussed within the context of the general theory of terrestrial planet formation by accumulation of planestesimals. The past evolution of the lunar orbit is of little use in differentiating between the theories, primarily because of the inherent uncertainty in a number of model parameters and assumptions. The various theories that have been proposed are divided into six catagories. Rotational fission and disintegrative capture appear to be dynamically impossible for viscous protoplanets, while precipitation fission (precipitation of Moon–forming material from a hot, extended primordial atmosphere of volatilized silicates), intact capture, and binary accretion appear to be dynamically implausible. Precipitation fission and binary accretion suffer chiefly from having insufficient angular momentum to form the Moon, while intact capture requires forming the Moon very close to the Earth without encountering any perturbations prior to capture. The only mechanism proposed so far that is apparently not ruled out by dynamical constraints and that also seems the most plausible involves formation of the Moon following a giant impact that ejects portions of the differentiated Earth's mantle and parts of the impacting body into circumterrestrial orbit. The Moon must have accreted subsequently from this circumterrestrial disk. The giant impact model contains elements of several of the other models and appears to be dynamically consistent with the absence of major satellites for the other terrestrial planets. While the giant impact mechanism for forming the Moon thus emerges as the theory with the least number of obvious flaws, it should be emphasized that the model is relatively new and has not been extensively developed nor thoroughly criticized. Much further work must be done to learn whether the giant impact mechanism for lunar formation can be made into a rigorous theory.