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Dynamos, Planetary Evolution and Life

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It is now clear that internally-generated dynamos are common among the terrestrial planets and small rocky differentiated bodies in the solar system. The list of bodies with present or past dynamos includes Earth (r=6,371 km), ancient Mars (r=3,389), Mercury (r=2,439 km), the ancient Moon (r=1,737 km), ancient Vesta (r$\sim$258 km) and the pallasite meteorite parent body (r$\sim$200 km). There appears to be no reason why core dynamos should not be found in terrestrial-like exoplanets. The outstanding question is the role (if any) of internally-generated magnetic fields for the development of life. A common misconception is that the dominant effect will be a shielding of cosmic radiation that would otherwise be inconsistent with the development of life, but it is clear that an atmosphere and ocean layer can provide protection. Instead, the key issue is the preservation of a planetary atmosphere (and water) from stellar wind erosion, and it is here that dynamos play an important role. The preservation potential will in turn depend on the balance of stellar wind pressure and magnetic field strength. For terrestrial planets the salient variables are the time of onset and duration of the dynamo (which are related to the efficiency of heat removal from the core), especially during the first billion years after planet formation. Stellar wind history will be a function of star spin rate and stellar evolution. I will discuss what is known about these variables based on observations for dynamo onset and duration on Earth and Mars, and use these to bound histories for terrestrial-like exoplanets.