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Magnetic Measurements in Hot Planetary Environments

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While space exploration generally involves measurements where the temperature is low and can be restored to a normal operating range by heating the sensor, there are regions of space in which the environment is hotter than the laboratory, and it would be desirable but not easy to cool the sensor. Unexplored hot regions include the surface of Mercury, except very near the poles, the surface and atmosphere of Venus even at the poles, and planetary probes into the deep atmosphere of Jupiter. Magnetic measurements are highly desirable in all these regions, but the sensor has to be outside the spacecraft or lander where active cooling is impractical, and passive cooling impossible. Thus the sensors have to be designed to withstand the heat of the environment in which they must operate. The UCLA fluxgate magnetometer has no active parts in the sensor so that it is a candidate for operating at high temperatures. We have examined the materials available for replacing the present wiring and sensor structure that supports the windings and find that there are distinct temperatures at which the mechanical design needs to be altered with increasing cost and difficulty of machining, but that there are no limitations until the temperatures that affect the magnetic properties of the core material. In this paper we review what needs to be done to build a 'high' temperature fluxgate sensor, as well as what can be accomplished with the resulting design.