ULTRA SENSITIVE MAGNETOMETER FOR SPACE EXPLORATION

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The measurement of the magnetic field in space is essential to study the heliosphere and the planets of our solar system. This measurement is currently based on the simultaneous use of two different instruments, which are rather large and heavy. In this context, we aim at developing a miniature and ultra-sensitive magnetometer that could replace these instruments with a significant mass reduction. Such a small sensor would be perfectly suited to the new "nanosatellites" that are about to revolutionize space exploration, and whose typical volume is 1 to 9 dm3.

Our objective is to reach a detectivity of 1 pT/√Hz to 100 fT/√Hz in the DC-10 kHz range using magnetic tunnel junctions and microfabrication techniques derived from microelectronics. This extreme performance should be achieved by amplifying the field to be measured with a flux concentrator and using a field modulation technique to reduce noise. As part of this study, we developed the technological building blocks for the sensor: the polarization coils embedded in the substrate, the high gain flux concentrator (G=400) fabricated by electrodeposition of permalloy and the magnetic tunnel junctions. The whole process requires about 50 microfabrication steps and 8 mask levels. A significant part of the work is devoted to optimizing the tunnel junction with a specific attention on micro-magnetism and noise issues.