First measurements of the Mesospheric Magnetic Field in the Auroral Zone by means of laser

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In December 2019, for the first time, we were able to remotely measure the magnetic field in the mesospheric sodium layer, in the auroral zone.

By means of laser optical pumping and Larmor-resonance detection, it is possible to use the naturally occurring sodium layer in the mesosphere to measure Earth's magnetic field magnitude at 90 km above ground. This is an altitude otherwise only accessible by rockets, which only will provide point measurements of very short time scales.

During the winter of 2019-20 we have applied a cw sum-frequency fasor/laser for probing the sodium-atom Larmor resonance at the Artic Lidar Observatory for Mesospheric Research (ALOMAR) at Andøya in northern Norway in order to measure and monitor the magnetic field in situ in the high latitude mesosphere over longer time scales.

The technique, which has been proved earlier at mid-latitudes, has now been confirmed and applied to high latitudes in the auroral zone during disturbed auroral and geomagnetic conditions. The magnetic field in the auroral zone is close to vertical making our measurements a notable achievement since the beam is closer to parallel with the magnetic field, contrary to earlier measurements being closer to perpendicular as shown as best by theory.

This opens up for a completely new domain of measurements of externally generated geomagnetic variations related to currents in the magnetosphere-ionosphere system.

Here we report on the instrumental setup, and discuss our measurements of the mesospheric magnetic field.
