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Ultrahigh speed spectroscopy with GALIUS: A new lightning spectrograph

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We report on work in progress in connection with GALIUS (GrAnada Lightning Ultrafast Spectrograph), a new ultrafast lightning spectrograph developed within the Atmospheric Electricity group of the IAA-CSIC in Granada. Imaging and spectroscopic experiments were carried out with a small electrostatic generator (up to 300 kV) able to produce short (2-10 cm long) sparks that are used to mimic the channel of natural cloud to ground lightning in the laboratory. The speed recording of GALIUS was changed between 900 Kfps and 2.1 Mfps. Most flux and wavelength calibration tests have been already completed except for the near ultraviolet range (350-400 nm).

The spark spectra were recorded using three interchangeable volume phase holographic (VPH) diffraction gratings, namely VPH-VIS1, VPH-VIS2 and VPH-NIR, with corresponding central wavelengths (CWL) of 621 nm, 657.5 nm and 775 nm. The spectral range of each grating depends on the recording speed while their spectral resolutions are, respectively, 1 nm (VPH-VIS1), 0.42 nm (VPH-VIS2) and 0.42 nm (VPH-NIR).

GALIUS is able to record time resolved (0D) and space-time resolved (1D) spectra. 0D spectroscopy stands for conventional, non spatially resolved spectra while 1D high-speed spectroscopy uses the vertical dimension of the sensor to provide spatial resolution through the spark (or lightning) width. This allows to access to spatially resolved electron density and gas temperature along the tranversal section of a spark (or lightning) channel.

We show examples of high-speed spatially resolved (and non-resolved) spark spectra with results for the electron density and gas temperature derived from, respectively, the hidrogen alpha line and the ratio of nitrogen ion lines. We also show results of the spark luminosity and channel width at 900 000 fps.