Oscillations above sunspots near the limb

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A new method, which was introduced by Mattig and Zerfass (1988, Proc. Symp. Seismology of the Sun and Sun-like Stars, Tenerife, ESA SP-286, p. 273), is used to determine oscillations above sunspots. While oscillations of spots near the centre of the disk can be measured by means of Doppler-shifts and intensity fluctuations, the oscillations of a spot near the limb are directly visible as small spatial variations around a mean position in the spectrograms. The spectrograms are taken with the slit perpendicular to the limb and cutting the spot. The reference point for the measurements is the solar limb, which is known to show no oscillations. The dependence of the oscillations of the spot with height can be studied by analysing the spatial displacements of the spot in the centre, the wings and the neighbouring continuum of chromospheric spectral lines, because their centres are formed up to 2000 km above the photosphere.

The material consists of several time series of 1 hour duration taken with the Domeless-Coudé-Refractor at Capri (only in H$_\alpha$) and with the VTT on Tenerife (H$_\alpha$ and H$_\beta$ simultaneously).

Oscillations are clearly seen in both H$_\alpha$ line-centre and continuum of the Capri series. The amplitudes for H$_\alpha$ line-centre and continuum are approx. 250 km and 200 km, respectively. The oscillations of the continuum and H$_\alpha$ line-centre are strongly correlated, the phase angle is zero. Therefore it can be concluded that the atmosphere above a sunspot is oscillating coherently. Power is found in the well known 5 mHz region (H$_\alpha$ line-centre and continuum) and at 11.5 mHz (continuum). On the other hand there is no distinctive power at 3.3 mHz, where the normal photospheric oscillations would be expected.

The second series (H$_\alpha$ and H$_\beta$ simultaneously) is presently being analysed and results will be presented at the conference in Freiburg.