First Observation of a Solar X-class Flare in the Submillimeter Range with KOSMA

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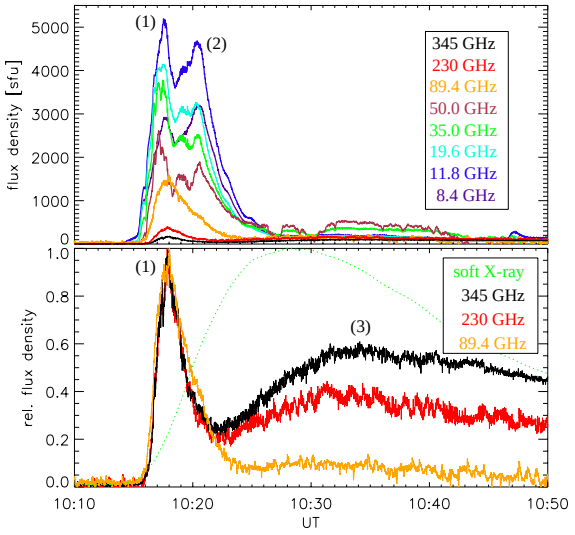
Abstract

The University of Bern operates six telescopes dedicated to solar flare monitoring at frequencies from 8.4 to 89.4 GHz. During early April 2001 additional observations at 230 and 345 GHz were made using the sub-mm telescope KOSMA of the University of Köln on the Gornergrat (Switzerland).

On April 12, a (GOES) X-class flare in the active region 9415 was observed at all 8 frequencies, extending the frequency range of solar flare observations into the high millimeter- and submillimeter region which is still nearly unexplored.

The preliminary examination of the temporal and spectral behaviour of the flare emission shows a spectrum with a peak frequency at cm-wavelengths during the impulsive phase and thermal emission during the extended phase of the event.

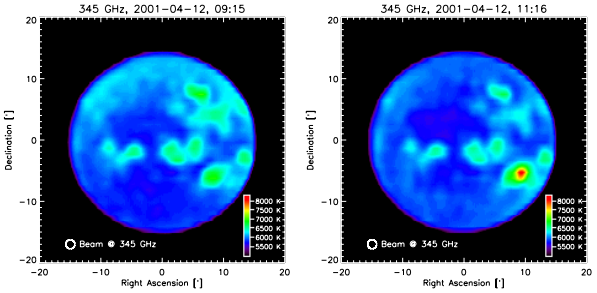
Observed fluxes



At lower frequencies the flare shows two peaks at about 10:17:30 (1) and 10:20:30 (2), whereas at higher frequencies just a single peak at 10:17:50 (belonging to 1) is visible. The observations made at 35.0 and 50.0 GHz are slightly affected by bad weather conditions (clearly visible after 10:25). The low frequency behaviour with components (1) and (2) is confirmed by observations made at 3 GHz by the Astronomical Institute of Ondrejov (Czech Republic).

At ∼10:22:30 a third and strong component (3) appears at frequencies above 50 GHz, which is also visible in soft X-rays (GOES-8, 0.1-0.8 nm).

Maps



Unlike the patrol telescopes which cover the whole sun with their beams, KOSMA produces also spacially resolved images of the sun. This feature is used to find the most active region which will then be tracked to obtain flux time profiles simultaneously at 230 and 345 GHz.

Roughly one hour before and after the flare two maps were made, which clearly show a strongly increased brightness temperature following the impulsive phase of the event.

Acknowledgements:
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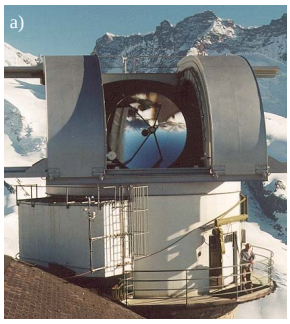
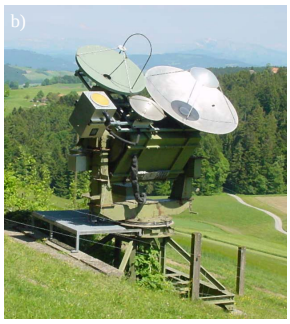
GOES-data was contributed by the U.S. Department of Commerce, NOAA, Space Environment Center.





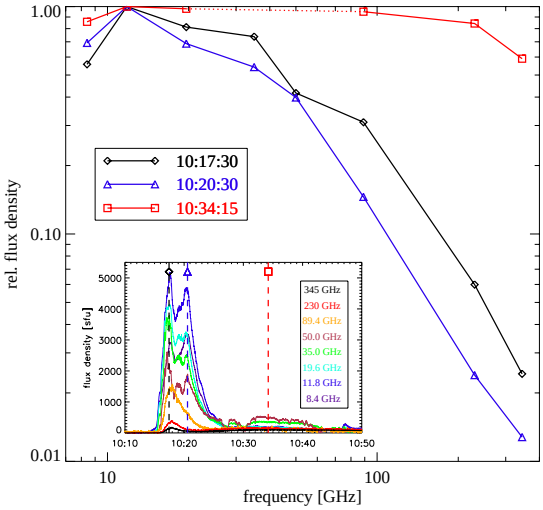
Instrumentation

a) The KOSMA (Kölner Observatorium für Submillimeter und Millimeter Astronomie) 3m-radiotelescope on the Gornergrat is operated by the University of Cologne. During our observations it was equipped with a dual-channel SIS-receiver operating in the frequency bands of 210-270 GHz and 330-365 GHz, tuned at 230 GHz and 345 GHz.

b) The University of Bern operates five patrol telescopes at 8.4, 11.8, 19.6, 35.0 and 50.0 GHz at Bumishus (∼10 km S of Bern).

c) A sixth patrol telescope at Bern observes at 89.4 GHz. It operates as a nulling interferometer cancelling the flux of the quiet sun and providing a high sensitivity that is not affected by fluctuations in the atmospheric transmission.

Instantaneous frequency spectra



The instantaneous frequency spectra during the impulsive phase of the flare show a maximum at 11.8 GHz. Above 50 GHz they follow a power-law with an index of approximately -1.7.

In the extended phase the spectrum becomes nearly flat indicating thermal emission (the observations at 35.0 and 50.0 GHz are omitted due to bad weather conditions at Bumishus). This thermal flattening is consistent with the enhanced soft X-ray flux observed by GOES.

Conclusions

The flare of April 12 was observed from the cm- to the submm-region. The fluxes show three components: two peaks with a steep spectrum during the impulsive phase and a slow component of possibly thermal origin in the extended phase. For a more detailed interpretation of the different emission components detailed modelling with gyro-, synchrotron- and thermal emission will be carried out in the near future. Further observations at mm/submm-wavelengths with KOSMA are planned.