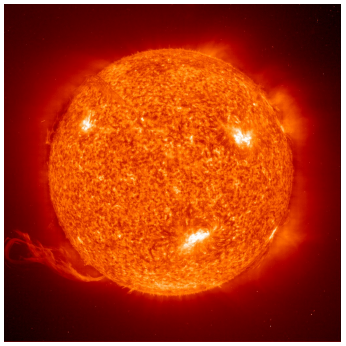

Solar Physics with LOFAR

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AIP

LOFAR – Low Frequency Array

- greatest ground based radio interferometer
- frequency range: 30 – 240 MHz
- ASTRON in Dwingeloo (Netherlands) centre of the array
- observation of the radio radiation from the corona

Leibniz Gemeinschaft

GLOW

German Long Wavelength Consortium

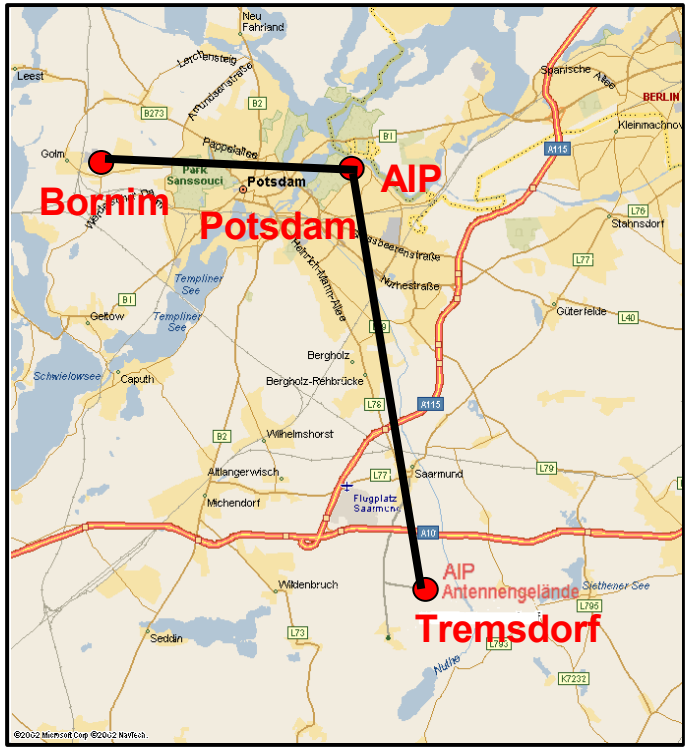
GLOW:

collaboration of 10 German instituts
with ASTRON

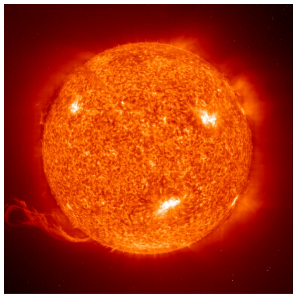
- MPI f. R., Bonn
- Univ. Bochum
- MPI f. A., Garching
- Univ. Bonn
- IGB, Bremen
- Hamburger Sternwarte
- FZ Jülich
- Univ. Köln
- AIP, Potsdam
- TLSW, Tautenburg

7 remote LOFAR stations in Germany

Remote LOFAR Station at the AIP



location of the remote LOFAR station at the observatory



Solar Physics with LOFAR

AIP

The Sun is an active star.

LOFAR will be able to monitoring the solar activity

scientific topics:

- plasma processes related to highly energetic electrons
- initiation of CMEs as the hugest form of solar activity
- formation and development of shocks
- generation of energetic particles

complementary ground-based observations to space missions (e.g. RHESSI, STEREO, Solar B, SDO)

LOFAR

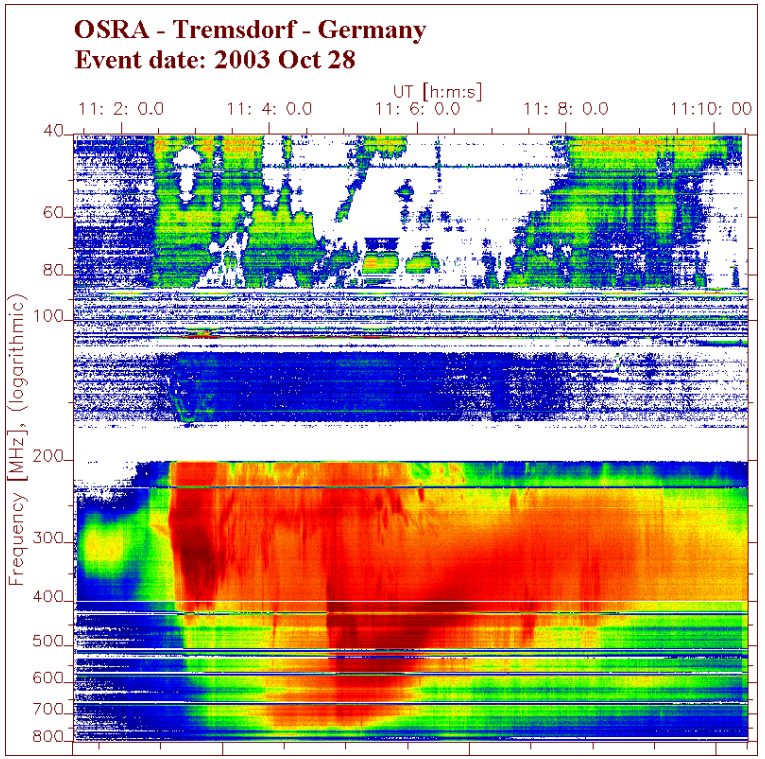
→ ***Solar Science Data Center at AIP***

Solar Radio Radiation

The Sun is a radio emitter.

nonthermal solar radio radiation

– sensitive indicator of ***solar activity***



Observatory of Solar Radioastronomy in Tremsdorf

`http://www.aip.de/groups/osra/spectra`

new spectralpolarimeter (40 – 800 MHz)

Solar Radio Radiation

The Sun is a radio emitter.

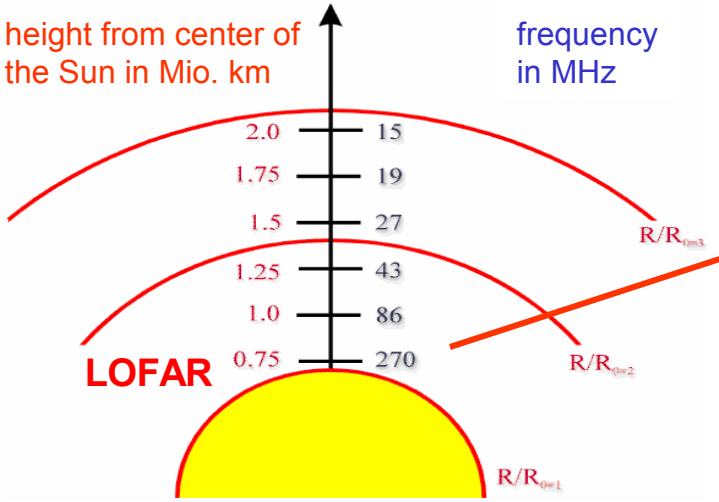
nonthermal solar radio radiation

– sensitive indicator of ***solar activity***

radio wave emission → plasma emission

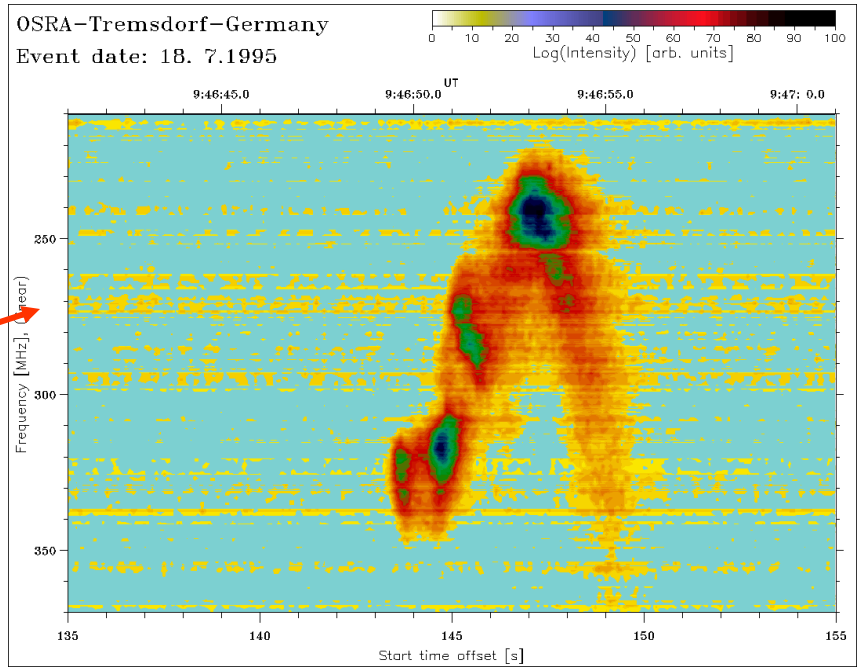
$$f \approx \sqrt{e^2 N_e / \pi\, m_e}$$

heliospheric density model (*Mann et al., 1999*)



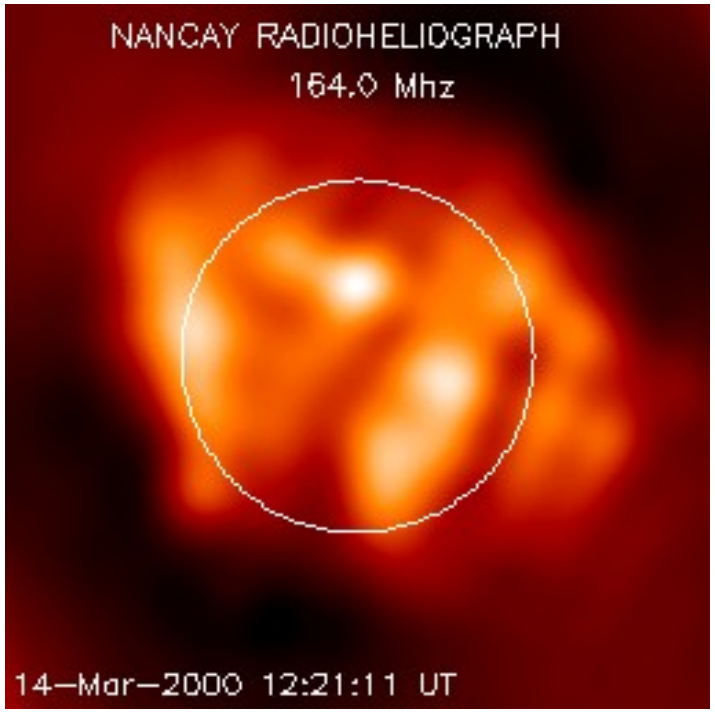
height ≙ frequency

velocity ≙ drift rate



dynamic radio spectrogram ↔ height-time diagram

Solar Observations with LOFAR



Nancay radio heliograph image
(resolution 60“ = 43000 km)

- theoretical resolution 2“
- due to scattering of radio waves in the corona → resolution 40 – 60“

→ **LOFAR‘s core stations are sufficient enough for observing the corona.**

- LOFAR will provide radio images of the Sun from the low up to the high corona.

LOFAR will provide radio images of the Sun with a resolution of few 10“.

Tasks of the Solar Physics Department at the AIP

LOFAR will be able to monitoring the high corona of the Sun by measuring the solar radio radiation in the range 30 – 240 MHz.

– scientific topics of LOFAR measurements.

- initiation of CMEs as the hugest form of solar activity
- formation and development of shocks in the solar corona
- generation of energetic particles (esp. electrons)

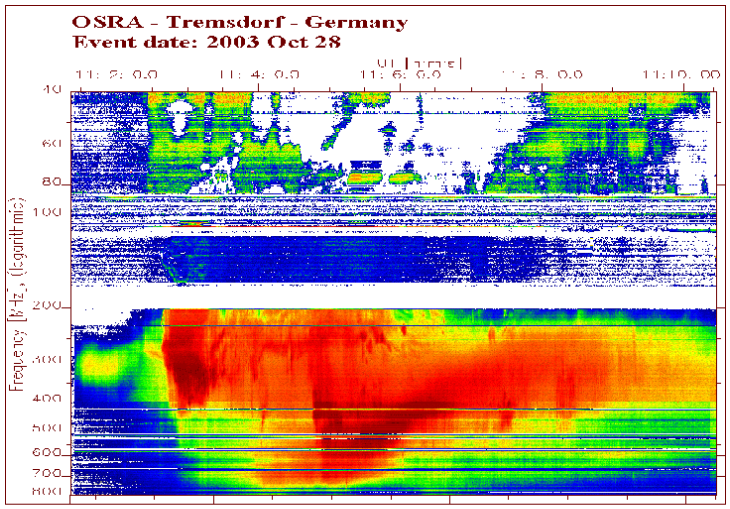
– complementary ground-based observations to space missions (e.g. RHESSI, STEREO, Solar B, SDO)

– ***Space Weather*** is of social relevance

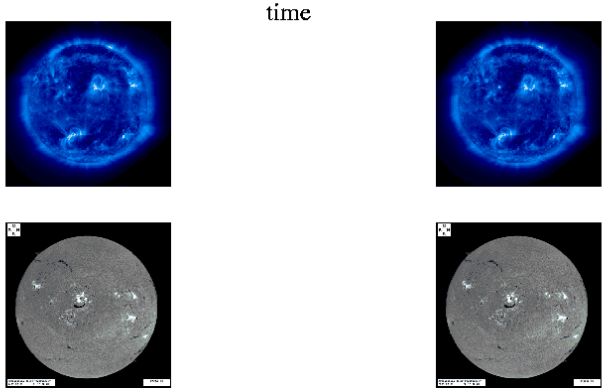
→ important for our funding agencies.

– included in ***GRID***

Monitoring the Solar Activity



Radio spectra
(Tremsdorf)



LOFAR images
(several frequencies)

Optical images
(e.g. Kanzelhöhe)

- observing the solar radio radiation at 40, 70, 150, and 200 MHz
- developing of a ***"burst bell"***

Space Weather

The ***Sun*** is influencing our ***Earth's environment***.

- ***solar flares – emission of electromagnetic radiation (radio – γ ray range)***

  → ionosphere
  → upper atmosphere

- ***energetic particles***
  (after 10 – 60 minutes)

  → northern lights
  → disturbances of electronic equipments

- ***Coronal Mass Ejections***
  (after 20 – 100 hours)

  → magnetic storms
  → disturbances of navigation
  → voltage flashes in pipelines

Scientific Objectives of LOFAR at the AIP

LOFAR enable fundamental new studies, from the Universe as a whole to the Earth's environment

- solar activity → solar stellar connection
- observations of flaring stars
- extragalactic astronomy
  - epoch of reionization of the Universe
  - formation and evolution of galaxies, clusters, AGNs
- galactic astronomy
  - absorption and polarization in the interstellar medium
  - supernova remnants: shocks and particle acceleration
- all sky surveys
  - intensity variations of radio sources
  - discovery of new objects
- Inclusion in GRID

All the subjects cover the interests of both diversions of the AIP.

European Collaborators Interested in Using LOFAR for Solar Physics

Contact	Affiliation	Country
Dr. Joe Khan	University of Glasgow	UK
Prof. Dr. Christoph Keller	TA Utrecht	The Netherlands
Dr. Karl-Ludwig Klein	Observatoire de Paris-Meudon	France
Dr. Michel Tagger	CEA Service d'Astrophysique, Gif-sur-Yvette	France
Prof. Dr. Joachim Vogt	International University Bremen	Germany
Prof. Dr. Bo Thidé	Swedish Institute of Space Physics, Uppsala	Sweden
Dr. Wolfgang Otruba	Sonnenobservatorium Kanzelhöhe	Austria

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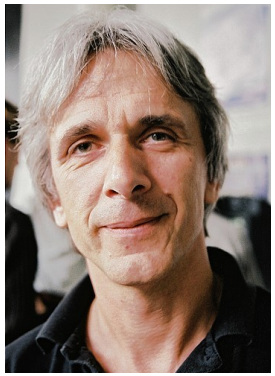
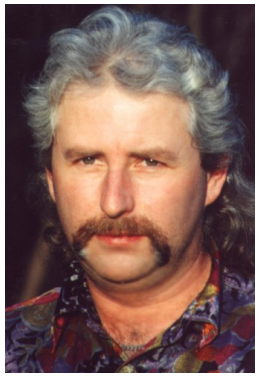
Dr. Henry Auraß



Dr. Harry Enke



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Dr. Christian Vocks
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Dr. Alexander Warmuth

Let‘s hope to realize our intentions concerning LOFAR