Name of research institute or organization:

Physikalisches Institut, Universität Bern

Title of project:

SONTEL - Solar Neutron Telescope for the identification and the study of high-energy neutrons produced in energetic eruptions at the Sun

Project leader and team:

Prof. Erwin Flückiger, project leader
Dr. Rolf Bütikofer

Project description:

The solar neutron telescope (SONTEL) at Gornergrat, Switzerland, has been in continuous operation since 1998 as the European cornerstone of a worldwide network for the study of high-energy neutrons produced in energetic processes at the Sun (Flückiger et al., 1998). The network consists of seven solar neutron telescopes that are located at high altitudes and at low to mid latitudes (short path through atmosphere) as well as at different longitudes (24 hour readiness to observe): Mt. Norikura (Japan), Yanbajing (Tibet), Mt. Aragats (Armenia), Gornergrat (Switzerland), Mt. Chacaltaya (Bolivia), Sierra Negra (Mexico) and Mauna Kea (USA). Figure 1 shows the locations of the seven solar neutron telescopes. The network was established during the nineties of the last century, i.e. it was almost completed at the beginning of solar activity cycle 23 that started in 1996.

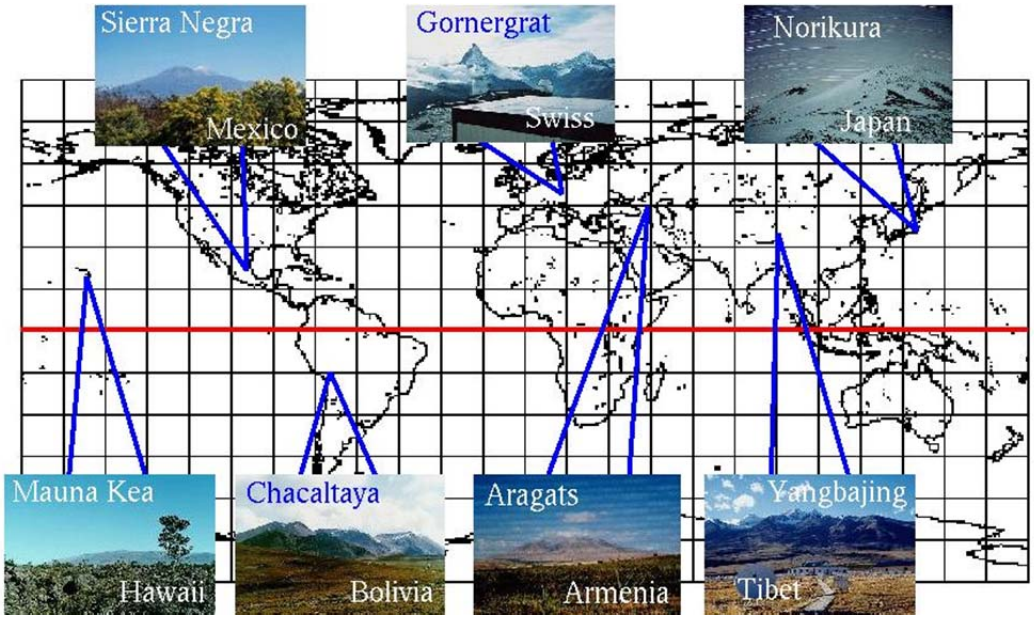

Figure 1: Worldwide network of solar neutron telescopes.

The detection of solar neutrons is essential for the understanding of the acceleration processes at the Sun as neutrons are not deflected by electromagnetic fields at and near the Sun nor in the interplanetary space. They therefore give direct information on the timing of their production at the Sun. Solar neutrons are produced in collisions of ions with atomic nuclei from the Sun, whereby the ions, namely protons, are accelerated in high-energy processes at the Sun. Several solar neutron events were detected by the worldwide network of solar neutron telescopes during solar cycle 23, e.g. the event on 7 September 2005, which was observed by the solar neutron telescopes as well as by the neutron monitors in Bolivia and in Mexico (Sako et al., 2006). The next solar cycle (solar cycle 24 that started in 2008) could be very interesting in the investigation of solar neutrons because in addition to the ground based cosmic ray detectors, two interesting new spaceborne experiments have just started their operation in the last years. The Solar Optical Telescope (SOT) onboard the Japanese satellite Hinode (launched in September 2006) is able to measure the magnetic field at the Sun with a resolution in space of 0.3 arcsec. For the understanding of the particle acceleration processes at the Sun detailed information on the structure of the magnetic field is essential. The other new space experiment is the scintillation fiber detector FIB (a detector of the Space Environment Data Acquisition Equipment - Attached Payload (SEDA-AP) onboard the International Space Station (ISS)) that started operation in March 2009. FIB is sensitive to neutrons in the energy range from 15 MeV to 100 MeV, whereby this range picks up directly at the energy range that is covered by the solar neutron telescopes (100 MeV to 300 MeV). Together both detectors cover an energy range from 15 MeV to 300 MeV. The observation of the neutron energy spectrum gives information on the timing and the nature of the acceleration processes at the Sun. It can be expected that the observation of solar neutron events in solar cycle 24 with the networks of solar neutron telescopes and of neutron monitors as well as with the new spaceborne experiments FIB and SOT will provide important new information on the acceleration mechanisms of charged particles in high-energy processes at the Sun.

In addition to the solar neutron telescope, the University of Bern has also operated a conventional GammaTracer unit designed and manufactured by Genitron Instruments GmbH, Frankfurt, Germany, since 2002 to monitor the environmental radiation at Gornergrat. In 2010 the operation of SONTEL and of the GammaTRACER was continued. The solar activity during 2010 was somewhat higher than in 2009 but still low. As a consequence no solar flare candidates were observed that could have emitted a solar neutron flux observable at ground level.

References

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Sako, T., Watanabe, K., Muraki, Y. et al., Long-lived solar neutron emission in comparison with electron-produced radiation in the 2005 September 7 solar flare, Astrophys. J. Letters, 651, L69-L72, 2006.

Key words:

Astrophysics, cosmic rays, solar neutrons

Internet data bases:

http://cosray.unibe.ch
http://stelab.nagoya-u.ac.jp/ste-www1/div3/CR/Neutron/index.html

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