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Radio Observations during the partial solar eclipse of March 20, 2015 with the newly reconstructed automated radio telescope of the Aristotle University of Thessaloniki

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Abstract: We present the basic characteristics of a new, 11GhZ, 3.2m antenna constructed at the Aristotle University of Thessaloniki and the results of radio observations of the March 20, 2015 solar eclipse (of magnitude 38% in Thessaloniki).

1 Introduction

The construction of a new radio telescope in the Laboratory of Astronomy, allowed us to make a series of observations during the March 20, 2015 solar eclipse. These observations and subsequent results mark the beginning of a new instrument available for scientific research both for the Department of Physics of the Aristotle University of Thessaloniki.

2 Instrumentation

The new custom-made radio telescope of the Laboratory of Astronomy of the Aristotle University of Thessaloniki that was used for the observations was constructed by upgrading an old polar axis satellite antenna in 2014. The 3.2m axial dish is mounted on a fully automated computer-controlled equatorial mount. The total power observations were made at 11 GHz.

3 Observations

A series of bidirectional RA transits, before the eclipse was recorded. The data collected allowed us to find the intensity relation between the solar and lunar radio emission at 11 GHz. Subsequently the radio telescope tracked the Sun for the full duration of the eclipse. The RA transits were repeated both after the eclipse and in the following months (Fig.1).

4 Analysis

Analysis of the transits shortly before the eclipse showed the average background signal to be at 481.76 ADU while the maximum solar signal was at 1056.62 ADU. The signal from the moon was clearly at a maximum of 530.78 ADU. Further analysis shows the ratio of the solar intensity to the intensity of the Moon is:

$$I_S/I_M = 11.73 \quad (1)$$

Additional transit observations of the Sun and the Moon were made exactly one synodic month later (on April 18). They confirmed the previously observed intensity relation. As expected the intensity of the Sun dropped significantly during the eclipse. Occasional heavy cloud obscured the Sun, shown in

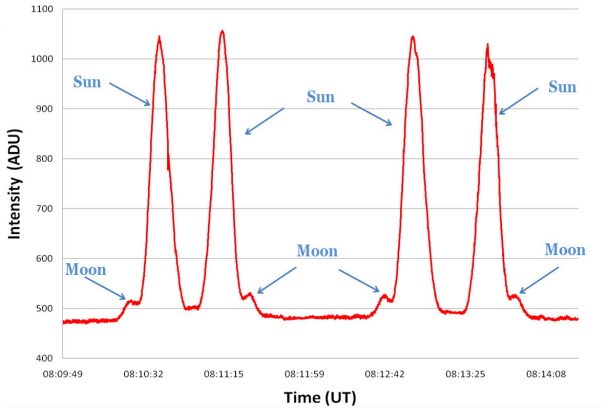

Figure 1: Four consecutive scans in RA across the lunar and solar disk, shortly before the beginning of the eclipse. The intensity of the Moon is evident, next to the much larger one of the Sun

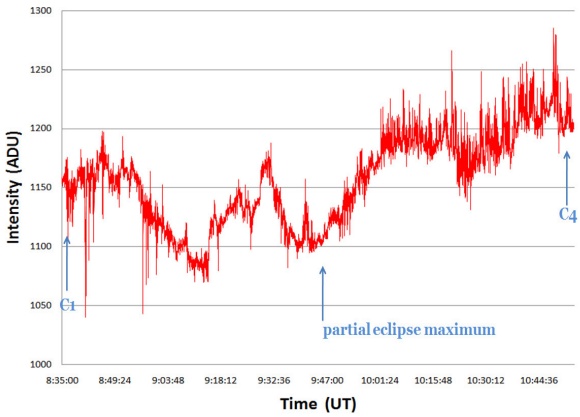

Figure 2: Between UT and UT the telescope was continuously following the Sun, 1st and 4 contacts are shown

as a temporary drop in its intensity (Fig.2), since at 11GHz water vapor absorbs significantly the solar radiation.
Random increases of the signal-to-noise are attributed to strong gusts of wind that forced a small change in the dish geometry due to mechanical tension. A small, continous increase in the background signal throughout the observation is attributed to the increase of the amplifier temperature and is in accordance with results taken from additional observations.

5 Results

The technical characteristics of the newly constructed 3.2m radio telescope of the Laboratory of Astronomy of the Aristotle University of Thessaloniki, operating at 11 GHz, are given.
Observations of the March 2015 total solar eclipse and the subsequent analysis of the data are presented. A reduction of the solar flux was observed during the partial phase of the eclipse. Before, after and a full-synodic-month-later, semi-synchronous observations of the Sun and the Moon give a ratio of the intensity of the two bodies of 11.73.
Although some minor technical issues still remain, further development in the hardware and analysis tools is in a state of ongoing process, involving students, young researchers and experienced scientists in the field.
This experiment demonstrates the importance of pioneer endeavors for scientific research undertaken mainly by undergraduate students in the field of Radio Astronomy.