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UPPER LIMITS FOR POLARIZED RADIATION FROM TLE GALACTIC CENTER IN THE FAR INFRARED.-

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Abstract

A balloon borne polarimeter used in the search for polarized radiation in the 100-2000 microns wavelength range has given an upper limit of 0.2% for the linear polarization of the Galactic Center.

1. - Introduction

Although a number of successful experiments in infrared astronomy have been carried out with airplanes, balloons and rockets, no effort has been, made, up to now, to investigate the state of polarization of the observed celestial sources in the far infrared.

On September 16, 1971 we launched a balloon-borne polarimeter with the aim of observing polarized radiation from diffuse and discrete sources in the wavelenghth range between 100-2000 microns.

The instrument has been described elsewhere (1): briefly it consists of a 25 cm f/4 Newtonian telescope, a rotating analyzer which modulates only the polarized radiation, and a liquid helium cooled Germanium bolometer. The signal is amplified and sincronously rectified into two channels 90 degrees apart in phase. Two other channels were added (derivative channels) to cut off any constant background arising from spurious polarizations or other instrumental effects.

The minimum detectable power (signal-to-noise ratio =3) for a 100% polarized radiation has been measured in the laboratory to be 4×10^{-15} watt cm^{-2} for sources with angular dimensions less than 0,8x0,8 degrees and 3×10^{-11} watt cm^{-2} $sterad^{-1}$ for extended sources (the systematic error during the calibration should be of the order of 20%). The minimum detectable percent of polarization has been tested to be of the order of 0.1%.

The polarimeter was tilted continuosly between 5° and 30° degrees above the horizon over a period of about 3 minutes, and the gondola was always points southward.

2. Observations

The balloon flew from Aire sur l'Adour in Francia at 16.05 UT on September 16, 1971. The region of the sky surveyed was between 17 h and 20 h in right ascension and -15° and -40° in declination.

During the rise of the balloon at about an altitude of 15 Km, due to gondola oscillations in azimuth, a strong signal was detected from the Sun, corresponding to a low percent of polarization. Further details on this observation are being published in (1).

Moreover an atmospheric polarized signal has been observed which should be caused by the scattering of the solar radiation by the atmosphere, even though the required efficiency of the scattering is much higher than that expected for molecules or other particles in the upper atmosphere in the far infrared. A more detailed report on this subject is in preparation. Other results relative to far infrared polarized sources will be published in a following paper.

The transit of the Galactic Center was expected between 17 h 58 m and 18 h 10 m UT, depending on the systematic error which arose while pointing the gondola toward South before the launch. Although the system worked correctly during this time as shown by the response to the on-board calibration source and by the response to the atmospheric emission(fig.1), no detectable signals were received.

3. - Discussion

To evaluate the minimum percent of polarization which may be detected by our system in the emission of the Galactic Center, we assumed a 100 microns intensity of 10^{-18} Watt.m^{-2}.Hz^{-1} and a power law between 100 and 2000 microns of the typex of $I = I_0/\lambda^{\gamma}$ .The trasmittance of our filters is given by the equation

$$T = 7,5\times10^{-6}\lambda^2 + 6.6\times10^{-3}\lambda - 0.58$$

with λ in microns(1).The covolution of the filter trasmission with the previously listed power law gives us an expected intensity of about 2×10^{-12} Watt.cm^{-2}.From this we are able to detect a polarized signal within the limits of the spurious instrumental polarization because a 0.2% polarization results to be equal to the minimum detectable power.Within these limits the Galactic Center appears to be non-polarized.

The state of polarization of the celestial sources has been used in the past to discriminate between thermal and non-thermal emissions.However,some optical sources have been discovered with a polarization which is due to the absorption by magnetically oriented grains or to the scattering with the sourronding cloud of grains(see,for instance 2),rather than to a non-thermal emission.On the other hand some non-thermal sources do not show any polarization in the radio region both for Faraday depolarization and for an intrinsic magnetic disorder(3).

The mechanisms of emission which my give rise to a polarization in the far infrared are:

i)sinchrotron emission

ii)emission by grains magnetically aligned(4)

We should point out that the Faraday depolarization is negligeable in the infrared if the rotation values are not much higher than those evaluated in the study of radiosource/. In the case of the Galactic Center we are in the presence of a number of not very well known sources:

1 - Near-Infrared sources: a dominant source coincident with Sgr A; a point source displaced 10" from the dominant source; an extended source.

2 - Intermediate-Infrared sources: an intense source of about 16" in diameter detected between 10 and 20 microns

3 - Far-Infrared sources: a strong source in Sgr A, an extended source of 3°x2° and several sources coincident with the major HII regions around Sgr A.

4 - Radio sources: a central source in Sgr A; an extended non-thermal source; an extended thermal source and several HII regions.

A review of the situation is found in (5).

We note that the sensivity of our instrument is such that only the polarization of the Far Infrared extended and compact sources may be detected.

The absence of any polarization rules out the sincrotron emission and indicates that the grains are not magnetically alligned. This result is in agreement with the fact that no polarization has been observed in the near infrared for the 16" source and the point source. The emission of these sources should be slightly polarized by the absorption of the aligned grains.

Figure Captions

Fig. 1: signals received in the 90° phase channel during the scanning of a celestial zone corresponding to the Galactic Center. Various scanning are displaced vertically to facilitate comparison. The signal due to the on-board calibration source is also shown. Each point is an averaged value over 20 measuraments. The increase of the background at low elevation angles is due to the atmospheric effect discussed in the text. The signals in the 0° phase channels are similar to those of 90° phase channel but the atmospheric effect is not detectable.

Reference

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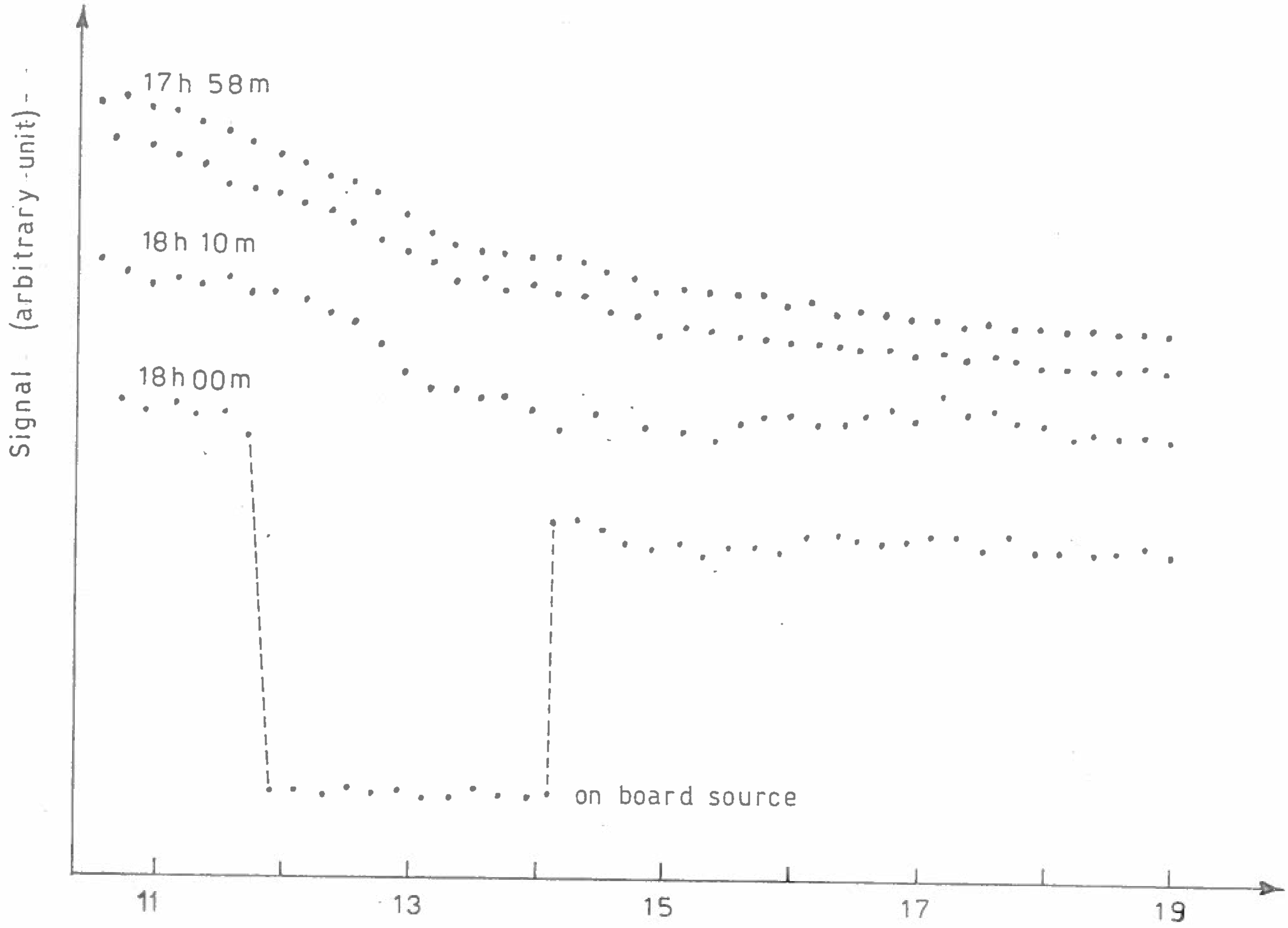

Signal (arbitrary-unit)
17h 58m
18h 10m
18h 00m
on board source
11
13
15
17
19