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Rocket measurement of solar fluxes at 1216Å, 1450Å and 1710Å

by

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FOREWORD

"Rocket measurement of solar fluxes at 1216Å, 1450Å and 1710Å" gives the results obtained from two rocket experiments launched in the frame work of the CERS-ESRO sounding rocket programme. This work will be published in "Solar Physics".

AVANT-PROPOS

"Rocket measurement of solar fluxes at 1216Å, 1450Å and 1710Å" reprend les résultats obtenus lors de deux tirs de fusées effectués dans le cadre du programme des fusées-sondes du CERS-ESRO. Ce travail paraîtra dans "Solar Physics".

VOORWOORD

"Rocket measurements of solar fluxes at 1216Å, 1450Å and 1710Å" geeft de resultaten weer van twee raketproeven, die in het kader van het programma raket-sondes van CERS-ESRO gelanceerd werden. Dit werk zal verschijnen in "Solar Physics"

VORWORT

"Rocket measurements of solar fluxes at 1216Å, 1450Å and 1710Å" gibt die Resultate von zwei Raketenexperimenten die durch CERS-ESRO geschossen wurden. Diese Arbeit wird in "Solar Physics" herausgegeben werden.

ROCKET MEASUREMENT OF SOLAR FLUXES AT 1216Å,1450Å and 1710Å

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Abstract

Values of the solar UV fluxes at 1216Å, 1450Å and 1710Å obtained by means of rocket borne spectrometers are presented. They are compared with other results.

Résumé

Les flux solaires mesurés à 1216Å, 1450Å et 1710Å à l'aide de spectromètres pour fusées sont présentés et comparés avec les autres résultats expérimentaux.

Samenvatting

De waarden van de zonneflux voor de golflengten 1216Å, 1450Å en 1710Å, bekomen met een spectrometer aan boord van een raket, worden hier weergegeven en vergeleken met andere experimentele waarden.

Zusammenfassung

Werte der Sonnenstrahlung mit Wellenlänge 1216Å, 1450Å und 1710Å, die durch Spektrometer tragenden Raketen erreicht wurden, werden vorgestellt. Die Ergebnisse werden mit anderen Resultaten verglichen.

1. INTRODUCTION

The knowledge of the solar ultraviolet flux reaching the earth is of fundamental importance in aeronomy. In the wavelength range between 1950Å and 1400Å, this radiation is mostly absorbed in the mesosphere and in the thermosphere. It initiates the photochemistry of neutral molecules up to the highest levels where physical processes such as diffusion take over to control the vertical distribution of atmospheric constituents. The photodissociation rate has to be determined as accurately as possible to define the lower boundary of the heterosphere. Several determinations have been performed that belong to two categories. Those fully pertinent to aeronomy (Detwiller et al., 1961) and dealing with the global radiation of the sun and those mostly interesting the solar physicists where the main objective is to caracterize the solar atmosphere (Parkinson and Reeves, 1969; Widing et al, 1970; Bruckner and Moe, 1972). In this latter case fluxes of photons issued from relatively small portions of the sun at suitable wavelength are mostly important. The total intensities is then obtained by spatial and spectral integration and the comparison with the global measurements is not straightforward. These determinations have however the advantage of giving the relative spectral distribution of the intensity with some uncertainty on the absolute value of the total UV flux.

This explains the need for accurate determinations of this absolute value at medium or low resolution and at some wavelengths to ajust the absolute scale of calibration for the high resolution data extending over the whole spectrum.

This is a report of an absolute rocket measurement of the total solar UV flux at one astronomical unit, at 1450Å and 1710Å with respective band passes of the order of 30Å and 10Å. This measurement has been undertaken with a double purpose. To help making a choise between the available values and to determine the vertical distribution of molecular oxygen in the thermosphere by absorptiometry of the solar UV. These latter results will be reported elsewhere. To extend the range of the oxygen measurement the Lyman α radiation was also determined.

2. INSTRUMENTATION

A 25 cm focal length Ebert-Fastie spectrometer shown in Figure 1 was used to select in sequence the three wavelength intervals shown in Figure 2. A diffusion lithium fluoride window was placed in front of the entrance slit to integrate the radiation over the whole solar disk. After diffraction by a fixed Lausch and Lomb 26 x 26 cm grating ruled at 1200 grooves per mm, the light was falling on an EMR 542 G-08-18 CsI photomultiplier after passage through one of the three exit slits. The slits were uncovered in sequence by means of a sliding shutter. The three wavelengths scan was performed every six seconds. The reflecting surfaces were coated with aluminium protected by a magnesium fluoride coating. The photomultiplier output was measured by means of a solid state electrometer followed by a three channel amplifier yielding a dynamic range of 10^4. Analog signals were transmitted to the ground. Two instruments were integrated by ESRO as part of Skylark paylod S 84 and S 90 on sun pointers. During flight an aperture opened at the rear of the instruments allowed their outgassing.

3. THE PHOTOMETRIC CALIBRATION

The absolute calibration of the spectrometers was based on various standards. The transfer between these was made by means of a sodium salicylate coated photomultiplier. This secondary standard was calibrated on the International Pyrheliometric Scale 1956 as for previous measurements (Ackerman et al, 1971) by means of a mercury lamp at 2537Å. At 1216Å, the instrumental sensitivity was measured by comparison with a CS_2 ionization chamber. In addition, the sensitivity of the sodium salicylate coated photomultiplier was measured by comparison at the Laboratory for Atmospheric and Space Physics, Boulder, Colorado, with an photodiode calibrated at the National Bureau of Standards. All calibrations agreed within 25%. At Lyman α a decrease of the sodium salicylate efficiency was found in agreement with the results of Knapp and Smith (1964).

The instrumental functions are shown in absolute value in Figure 2.

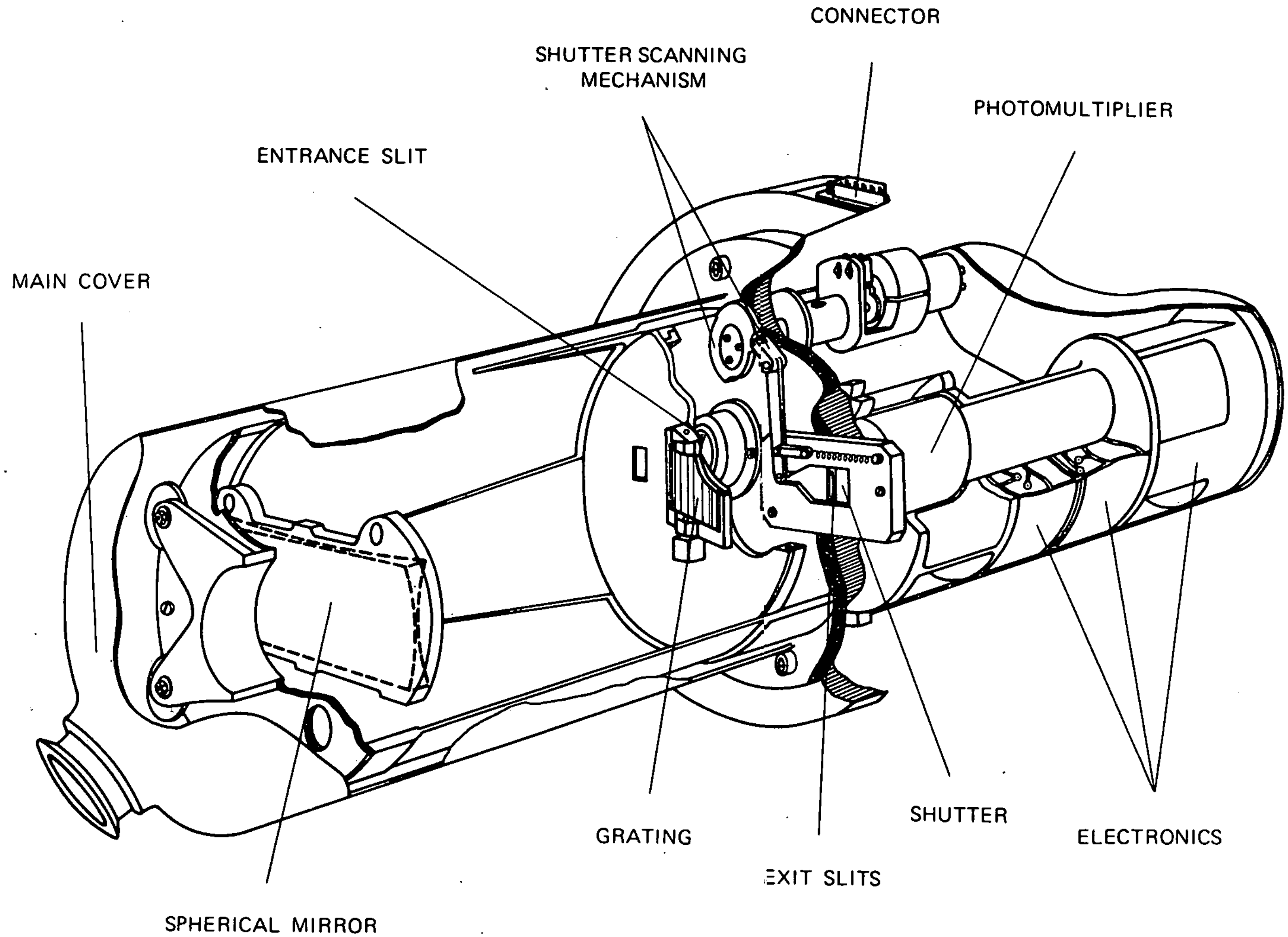

Fig. 1. View of the spectrometer.

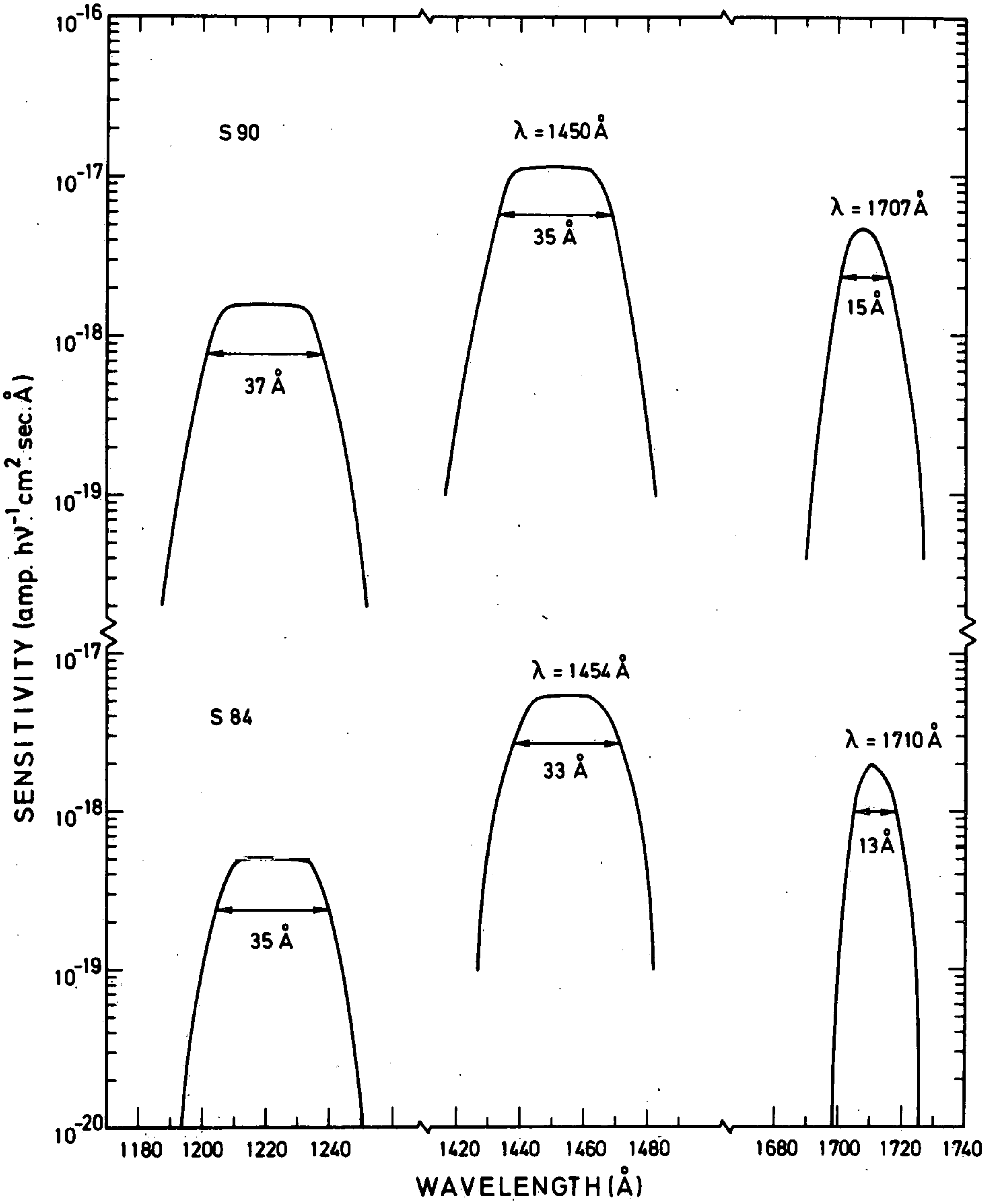

Fig. 2. Instrumental sensitivity versus wavelength for the three channels of both experiments : S 84 and S 90.

OBSERVATION

The two ESRO Skylark rockets were fired on February 28, 1972, at the Salto du Quirra launching range in Sardinia. The GMT launching times were 5h54 min for S 84 and 9h47 min 3 sec for S 90 and apogees of 242 km and 251 km were respectively reached. The Elliott sun pointing altitude control unit performed very well in both cases. The constant photomultiplier outputs observed at altitudes where no atmospheric absorption takes place have been used for the present determinations.

RESULTS AND DISCUSSION

The results are summarized in Table 1 and represented in Figure 3 where other observations are also shown. The value obtained at Lyman α is lower than the usually accepted average value of 3×10^{11} photons x cm^{-2} x sec^{-1}. As shown in Figure 4, the S 84 and S 90 flights took place when the Zurich sunspot number as well as the 10.7 cm solar flux were presenting low values. This can be correlated with low Lyman α fluxes also observed from the OSO V satellite (Blamont and Vidal-Madjar, 1971, 1972). At 1450Å and 1700Å the flux values presented here are lower than the values published by Detwiler *et al* (1961). They lead to solar blackbody temperatures intermediate between those obtained by Widing *et al* (1970) and by Parkinson and Reeves (1969). In these latter cases the comparison is however not straightforward. The values presented here are in agreement with those obtained from the satellite WRESAT 1 (Carver *et al*, 1972).

It is now certain that the apparent blackbody temperature of the sun can decrease by some 800° K from 2100 to 1600Å. The steps are possibly as follows : 5200° K at 2100Å, 4800° K at 2000Å, 4650° K at 1900Å, 4550° K at 1700Å and 4600° K at 1450Å with a minimum at 1600Å of the order of 4400° K.

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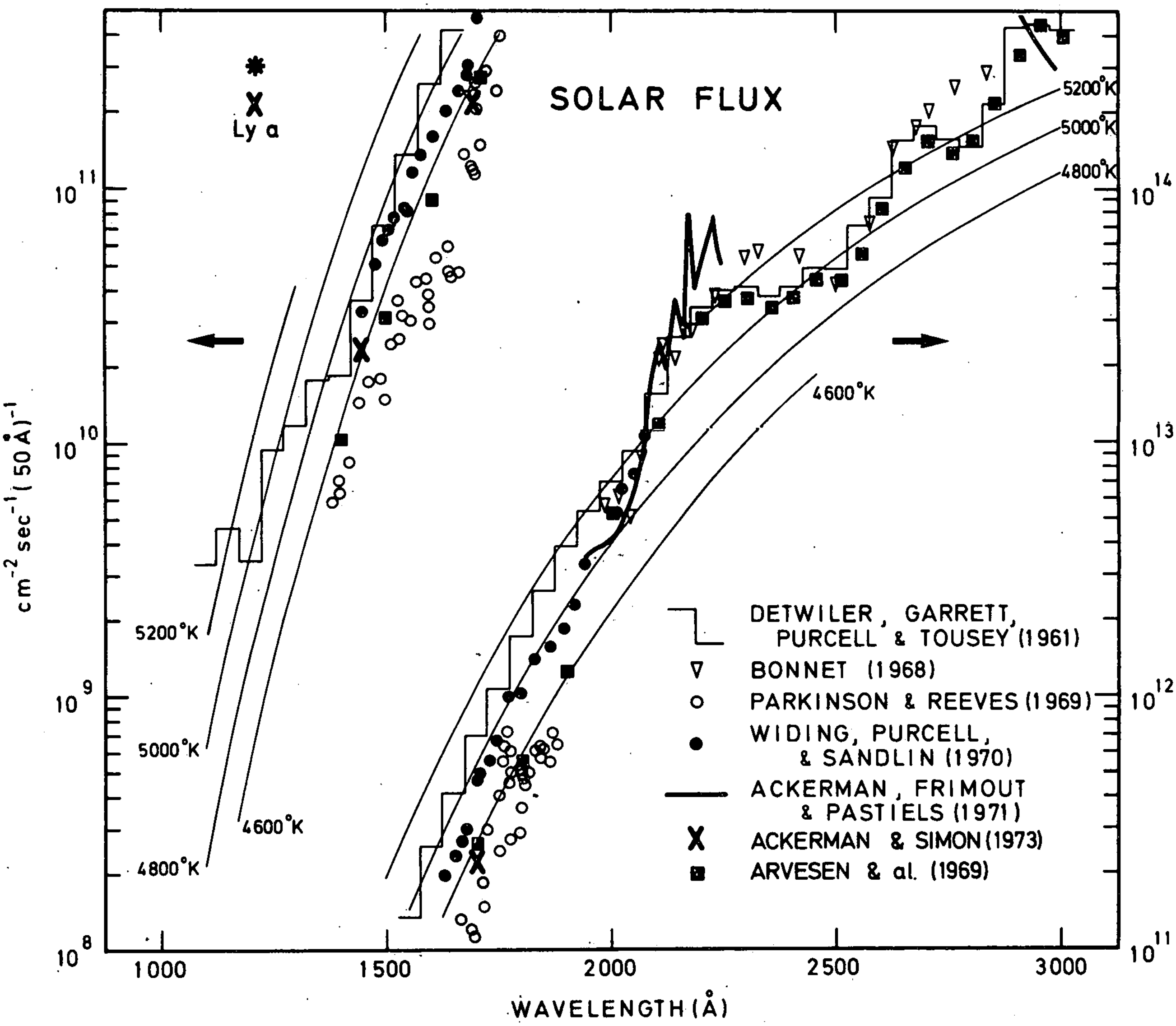

Fig. 3. Comparison of the results obtained by means of S 84 and S 90 with other observations.

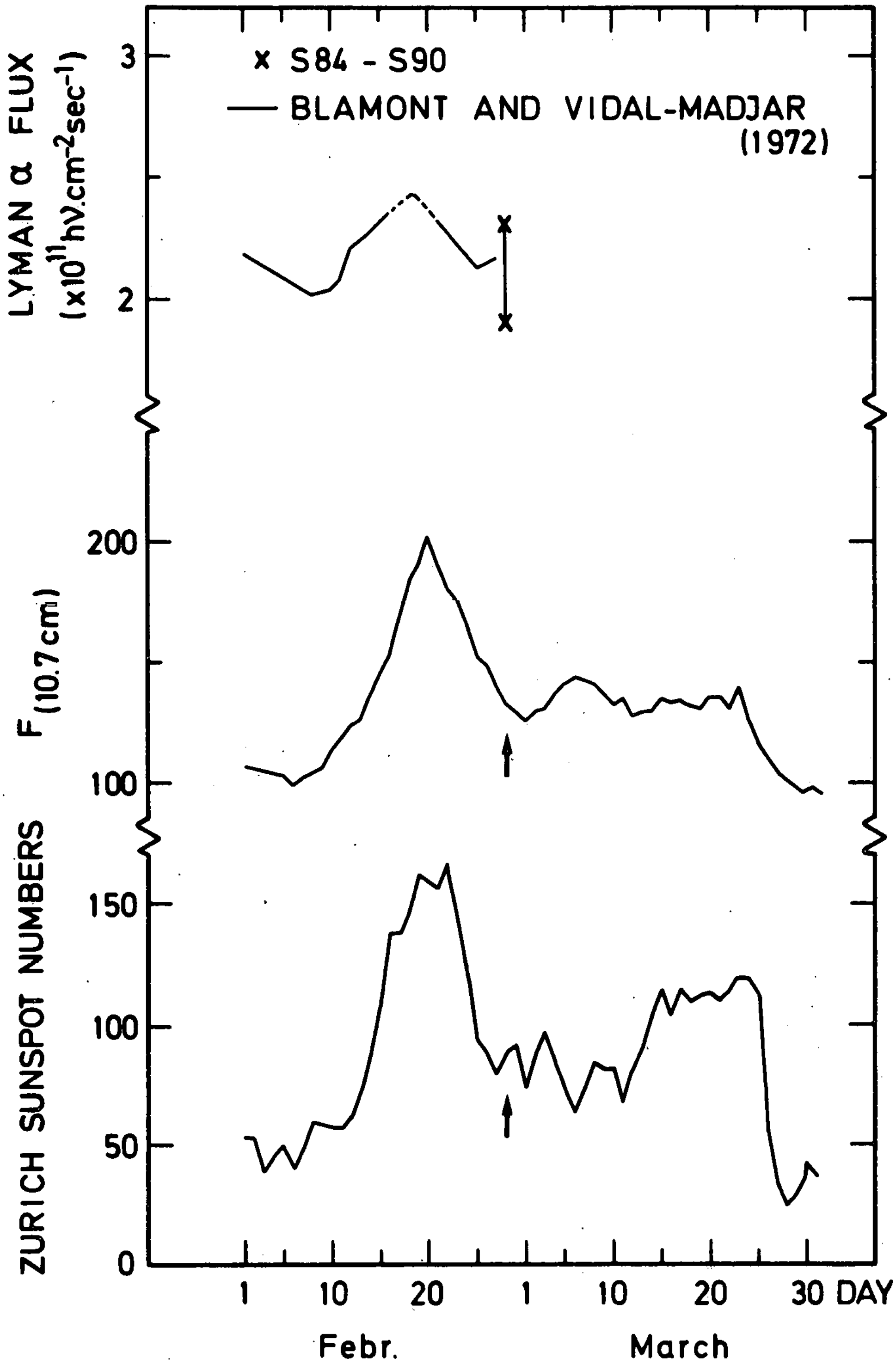

Fig. 4. Daily variation of Zurich sunspot numbers, radioelectric solar flux at 10.7 cm and Lyman α solar flux observed from the OSO V satellite. S 84 and S 90 experiments appear to have been performed at low solar activity.

TABLE I. Measured solar fluxes

	Ly α photons cm^{-2} sec^{-1}	1450Å photons $cm^{-2}sec^{-1}(50Å)^{-1}$	1710Å photons $cm^{-2}sec^{-1}(50Å)^{-1}$
S 84	$(2.1 \pm .3) \times 10^{11}$	$(2.68 \pm .4) \times 10^{10}$	$(2.29 \pm .4) \times 10^{11}$
S.90	$(2.1 \pm .3) \times 10^{11}$	$(2.01 \pm .3) \times 10^{10}$	$(2.24 \pm .4) \times 10^{11}$

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