(NASA-CR-196542) STUDY FOR THE ANALYSIS OF THE OBSERVATIONS, AND NUMERICAL DATA REPRESENTING THE PLANETS AS FAR-INFRARED CALIBRATION SOURCES Final Report (Alabama Univ.) 6 p

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RADIATIVE TRANSFER PROGRAM FOR ANALYSIS OF FAR-INFRARED KAO OBSERVATIONS

1. INTRODUCTION

This task was to numerically estimate the far-IR fluxes from the planets using the atmospheric models and compare them with the observed flux values from the KAO (KUIPER AIRBORNE OBSERVATORY) observations. The total observational uncertainties in the ratio of the fluxes from the planet and an asteroid were anticipated to be less than 9%. To these observational uncertainties must be added the uncertainties in the planetary models which describe the flux distributions of KAO standards. The observation strategy to achieve 10% absolute accuracy depends on observing several of the planets. Then compute the expected energy distribution for each planet using the best thermal-emission models available. The level of consistency in the calibrations resulting from these models is a measure of the fundamental uncertainty in the absolute calibration using the planets.

The observations were made on Mars and Uranus on 17 July, 1992. It is assessed that a comprehensive consideration of the planetary models will limit their contribution to the uncertainty of the asteroid calibration to under 8% at 160 μm. Combined with other uncertainties discussed previously, it is estimated that 10–12% for the total uncertainty in the absolute calibration of the asteroid fluxes, which is consistent with the goal. The results obtained so far in this program imply that the estimates of the uncertainties are realistic and within the tolerances required by ISO.

2. COMPUTATIONAL APPROACH

The previous comprehensive program could use a pre-selected instrument function to perform apodization of radiance, but it could not use a tabulated instrumental filter nor could it perform flux computation which is the integration of monochromatic radiance with an instrumental filter over a certain frequency band. Because fluxes emitted by the planet are received by observer from all directions, it was desired to computed the average flux.

The program was modified to satisfy our needs. Now it can perform flux computation over 300 cm^{-1} band width using any form of instrument filter (either a function or a table) as input. It can perform flux computation for any number of input filters. It can also perform the average of flux over whole field of view $0–180^0$ which can be reduced to $0–90^0$ due to symmetry. To make it computationally efficient, the integration of flux over whole field of view is carried out by using Simpson's rule which takes only three flux values corresponding to three observation angles: 0^0, 45^0 and 90^0. Compared with seven-angle integration result, the result from Simpson's rule is within 1%.

3. RESULTS

In this study, three filters are used: 60 μm, 100 μm, and 160 μm, with band width to be approximately equal to 33 μm or 300 cm^{-1} (see figure 1). The results are summarized in the table. The calculated ratios of fluxes are in reasonable agreement with the observed ratios. The calculated monochromatic flux density versus wavenumber (wavelength) are shown in figure 2 for Mars and figure 3 for Uranus and Neptune.

It is shown that the modified program can compute the planetary flux which is in agreement with the observed value.

Yerkes, KAO Observations : July 17, 1992

Uranus, S.D = 1.889"

	60μm/189 cm^{-1}			100μm/85 cm^{-1}			160μm/65 cm^{-1}		
Flux	Cal.	Obs.	% Error	Cal.	Obs.	% Error	Cal.	Obs.	% Error
F_{Mars}	5.31×10^{6}	3.29×10^{6}		1.695×10^{6}	5.25×10^{5}		4.71×10^{5}	3.96×10^{5}	
F_{Uranus}	6.00×10^{4}	3.12×10^{4}		2.47×10^{4}	9.50×10^{3}		2.533×10^{4}	2.24×10^{4}	
F_{Ceres}	5.13×10^{4}	2.07×10^{4}		1.582×10^{4}	4.10×10^{3}		4.885×10^{3}	3.54×10^{3}	
$\frac{F_{Mars}}{F_{Uranus}}$	885	105.4	$\overline{+}$ 16.0	68.6	55.26	$\overline{+}$ 24.2	18.5	17.67	$\overline{+}$ 5.2
$\frac{F_{Mars}}{F_{Ceres}}$	103.51	158.94	$\overline{+}$ 34.9	107.14	128.05	$\overline{+}$ 16.3	96.42	111.84	$\overline{+}$ 13.8
$\frac{F_{Uranus}}{F_{Ceres}}$	1.17	1.51	$\overline{+}$ 22.5	1.56	2.32	$\overline{+}$ 32.2	5.18	6.33	$\overline{+}$ 18.1

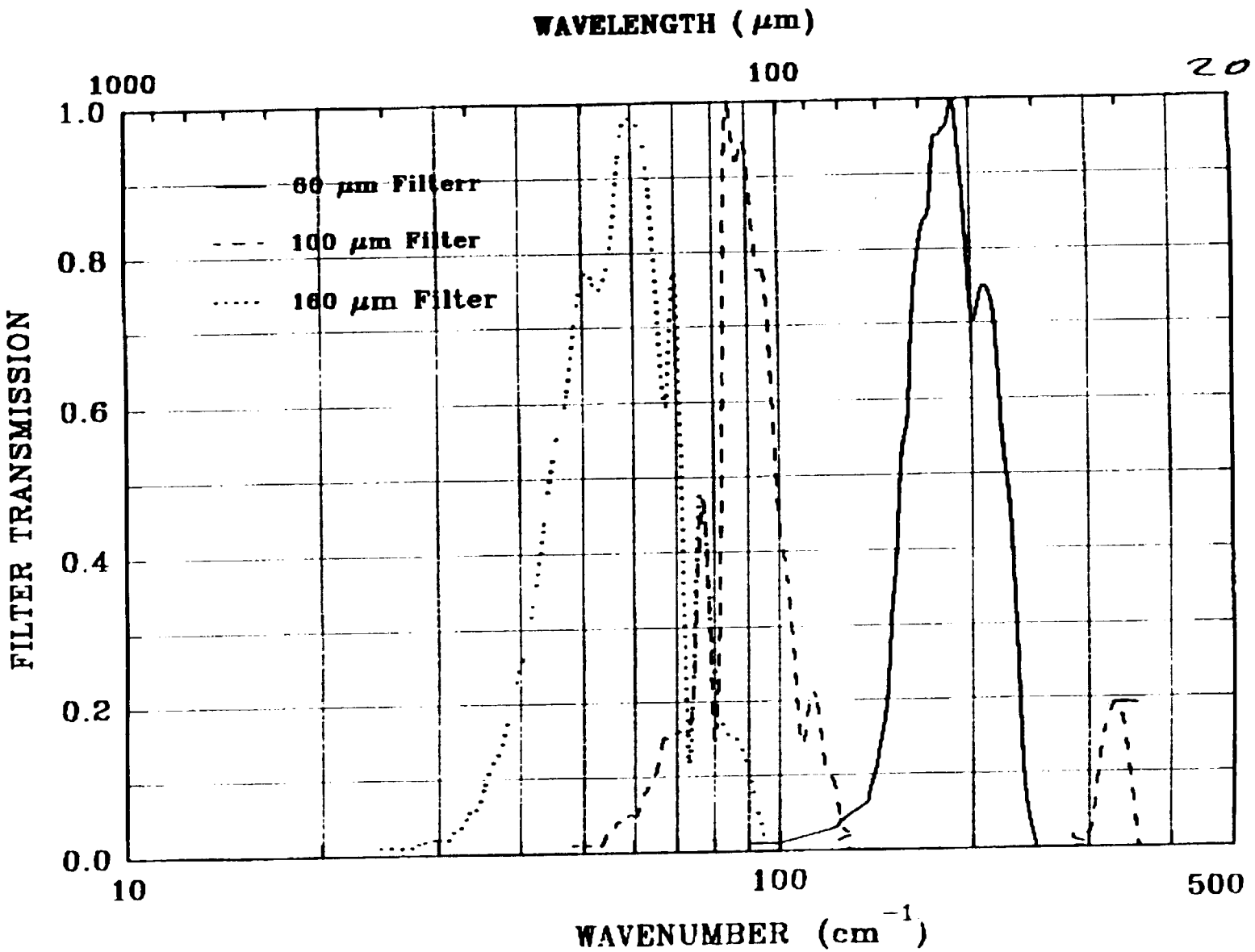

Fig. 1

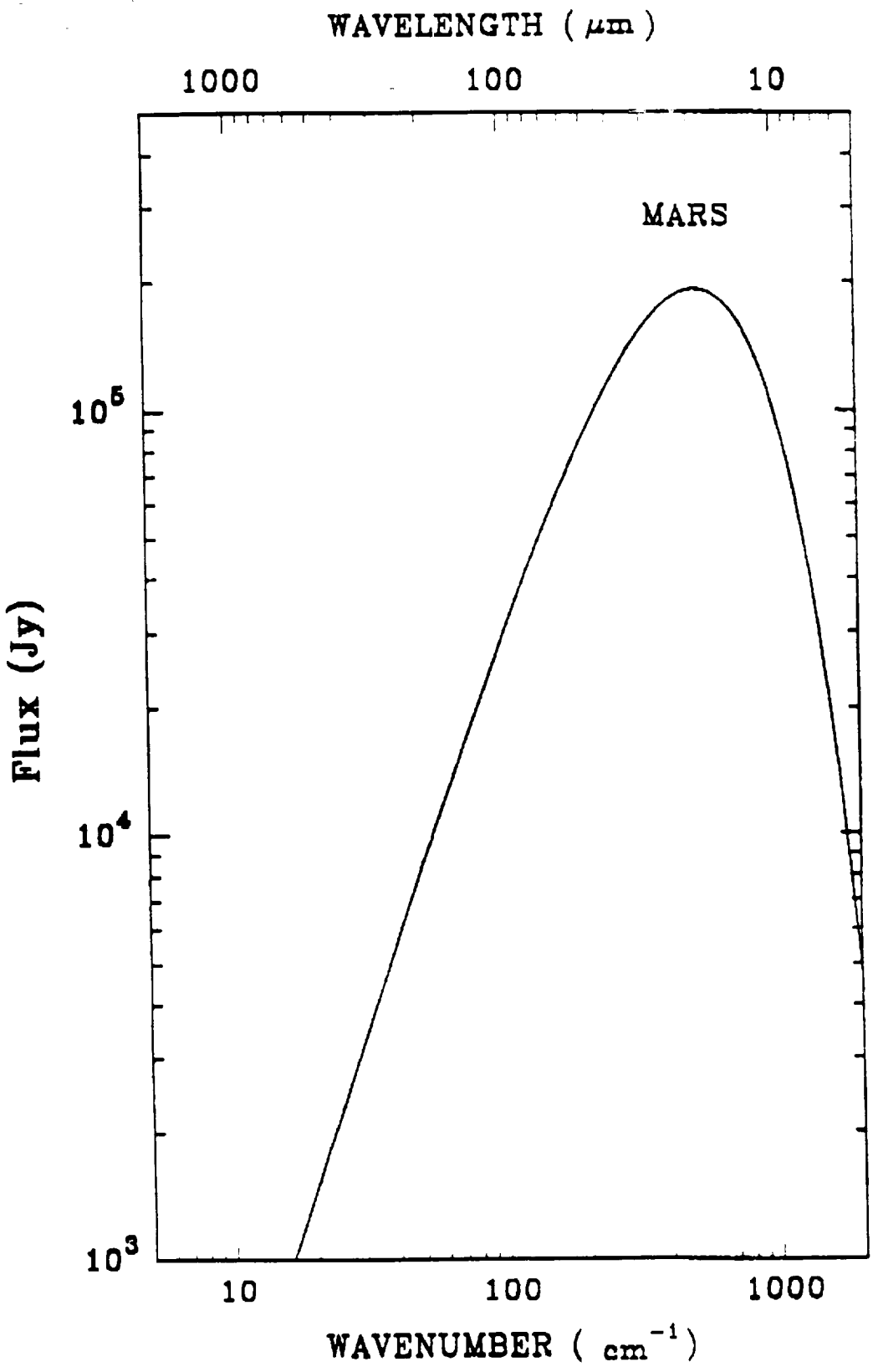
WAVELENGTH (μm)
1000
100
10
MARS
10^5
10^4
10^3
Flux (Jy)
10
100
1000
WAVENUMBER (cm^{-1})

Fig. 2

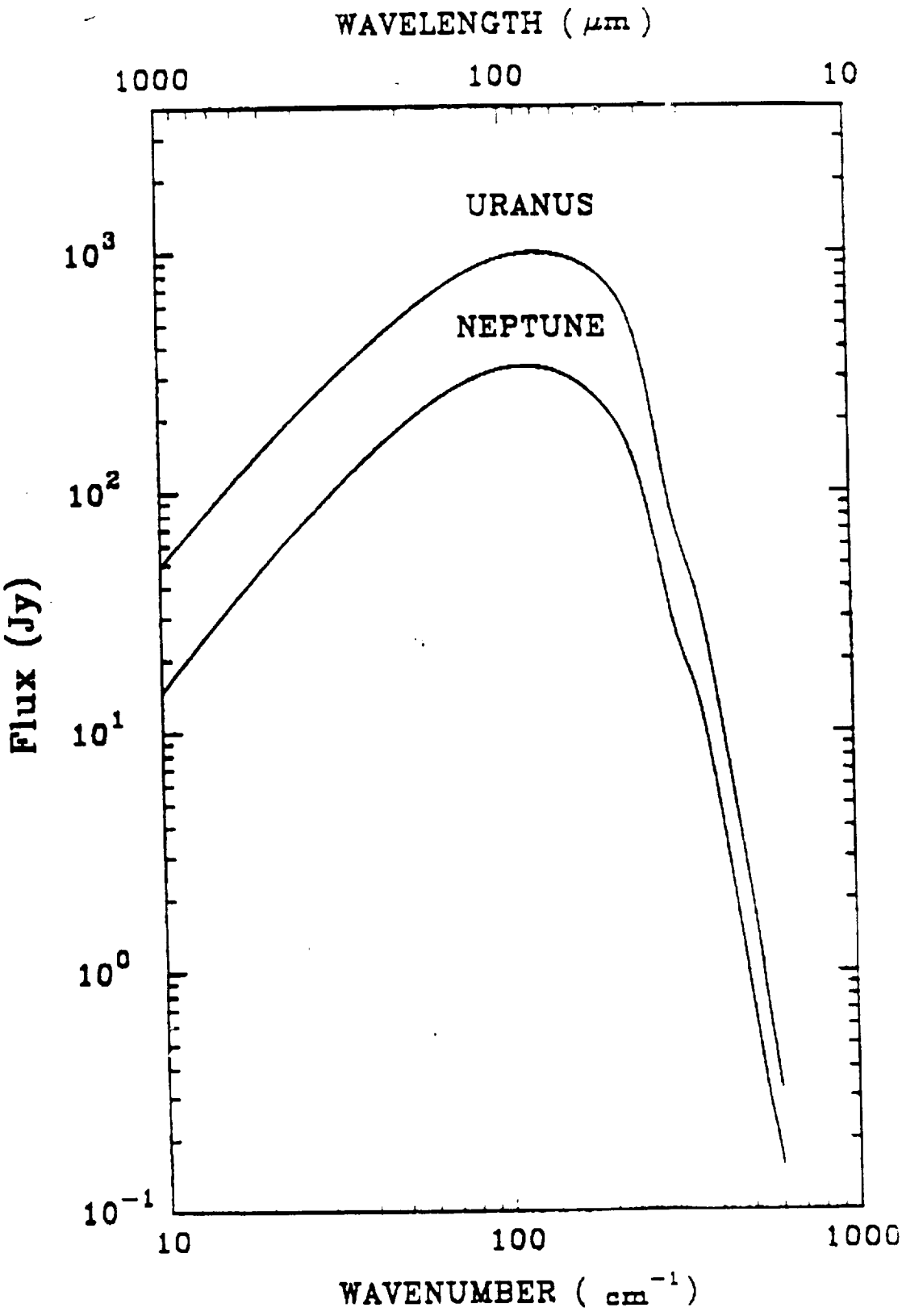
WAVELENGTH (μm)
1000
100
10
URANUS
NEPTUNE
10^3
10^2
10^1
10^0
10^{-1}
Flux (Jy)
10
100
1000
WAVENUMBER (cm^{-1})

Fig. 3

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16. Abstract

The existing radiative transfer and inversion programs will be modified for application to the atmospheres of Uranus, Neptune, and Jupiter. The programs will be employed for analysis of KAO planetary observations in order to develop far infrared photometric calibration standards. This work will be carried out on MSFC computers. The expected end product of this task is a working program for analysis of the observations, and numerical data representing the planets as far-infrared calibration sources.

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