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Final Status Report
For the NASA Airborne Astronomy Program

RELATIVE ABUNDANCE OF ICES IN DISKS OF PRE-MAIN-SEQUENCE STARS: IMPLICATIONS FOR COMET FORMATION

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Final Report

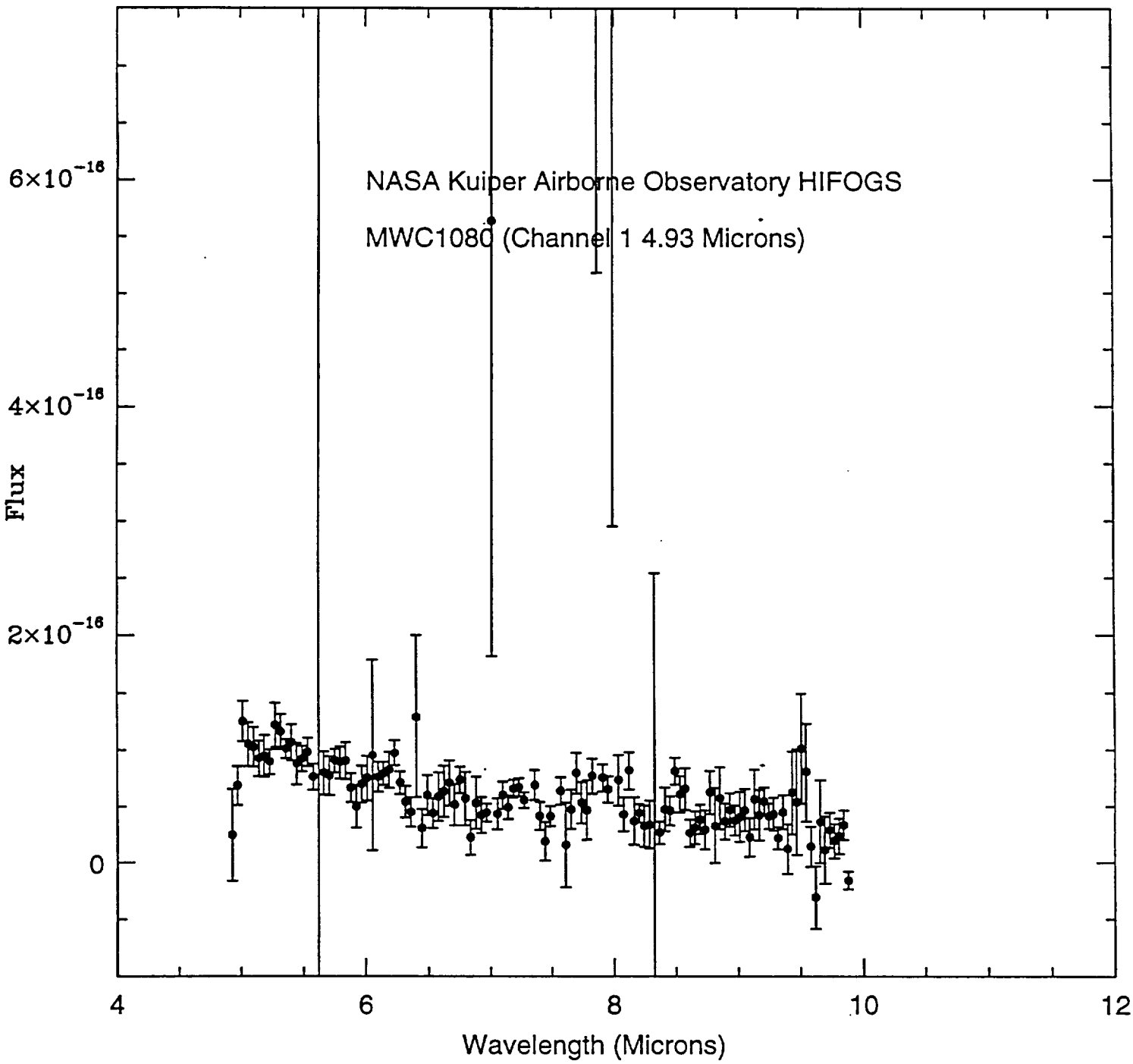
In this final report we describe research accomplished by the NASA Airborne Astronomy Program *Relative Abundance of Ices in Disks of Pre-Main- Sequence Stars: Implications for Comet Formation* over the period October 1, 1991 through September 30, 1993. An objective of our program was to determine the relative abundance of frozen methanol (CH_3OH) and other hydrocarbons, including refractory hydrocarbons, relative to frozen H_2O in disks around pre-main-sequence stars using 5 to 10 μm airborne spectroscopy. Another objective of our program was to compare the abundance of ices in circumstellar shells around protostars, in disks around pre-main-sequence stars (the observations in this project), and in comets to determine whether icy grains in disks result purely from grain surface chemistry or from grain surface chemistry and high energy processing. The increased knowledge of how ices evolve within disks around the pre-main-sequence stars in our program would constrain conditions in the protosolar nebula during the epoch of comet formation. The investigators included Drs. S.C. Tegler (Univ. Notre Dame), D.A. Weintraub (Vanderbilt Univ.), L.J. Allamandola, S.A. Sandford, F.W. Witteborn, J.D. Bregman (NASA/Ames), D.M. Rank (UC Santa Cruz), and H. Campins (Univ. Florida).

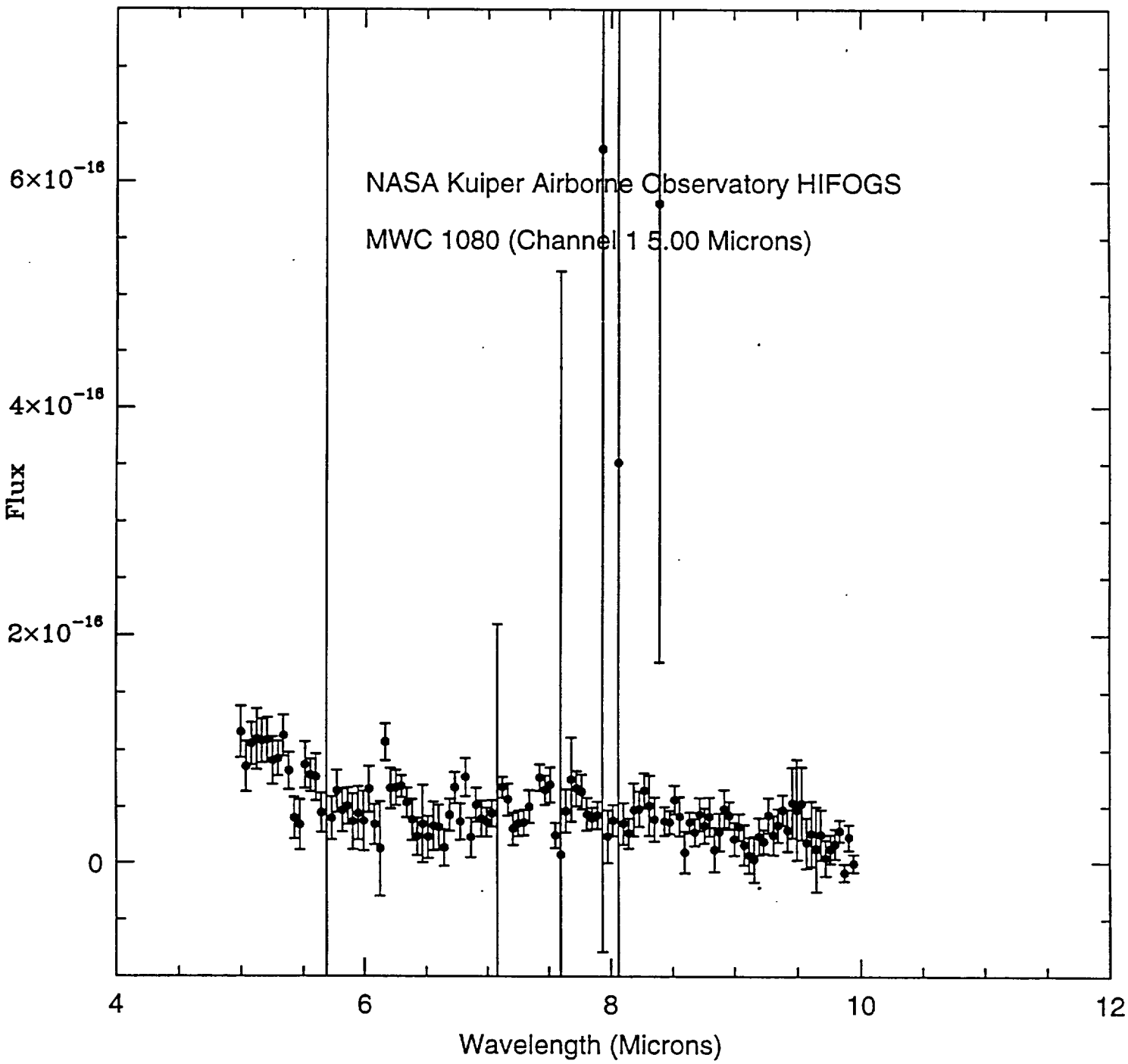
During October, November, and December 1991 we carried out preparations for our observations on the Kuiper Airborne Observatory (KAO). In particular we selected standard stars and guide stars necessary for the inflight identification and calibration of the target pre-main-sequence stars (Z CMa, RMon, VY Mon, and MWC 1080). We also developed a flight plan that maximized time available for observing the program objects.

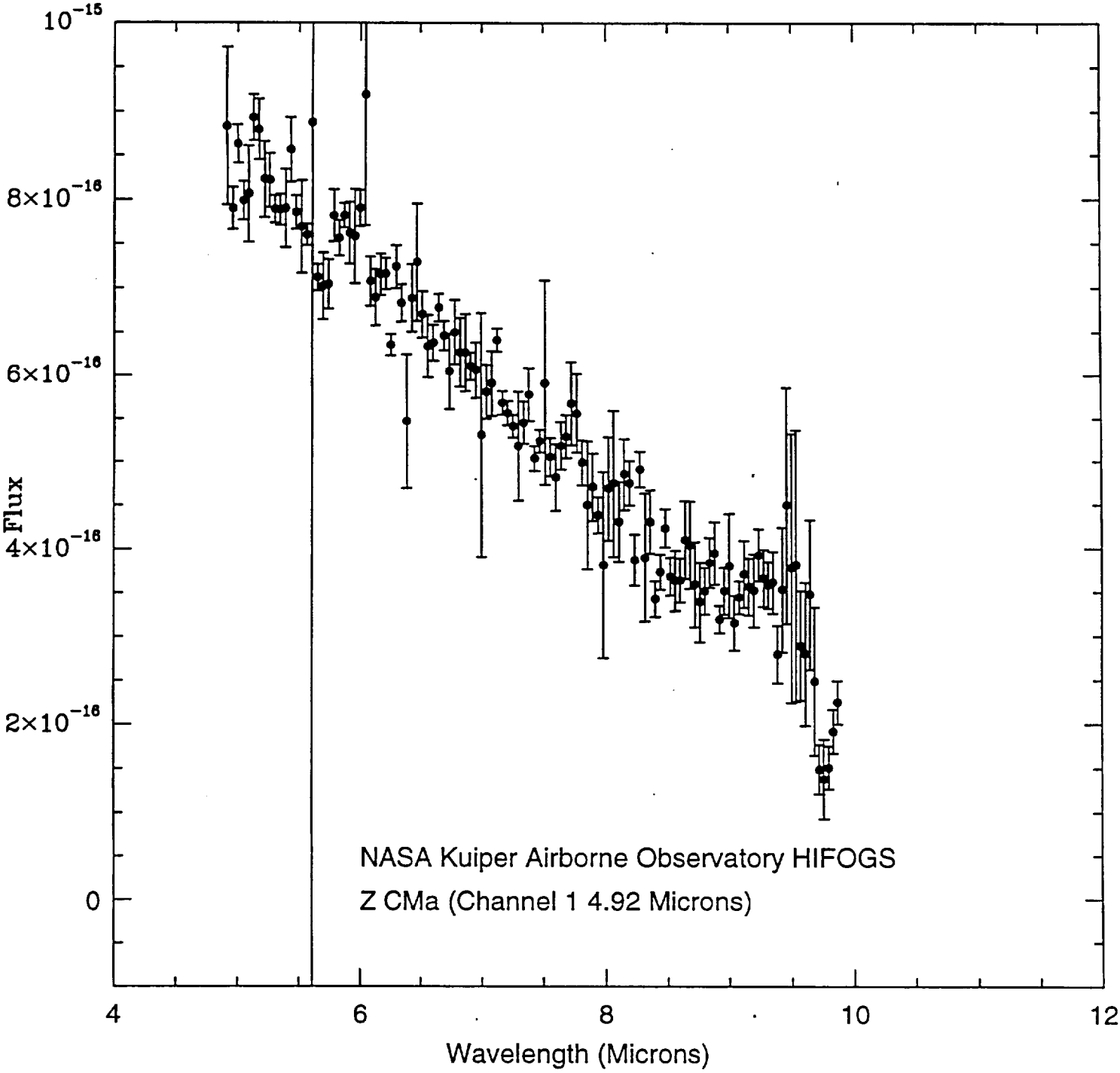
On December 23, 1991 the HIFOGS spectrometer was mounted on the KAO and we successfully obtained observations of Z CMa, RMon, VY Mon, and MWC 1080 during a seven hour flight. We obtained spectra of each pre-main-sequence star over the 5 to 10 μm wavelength interval at a resolution ($\lambda/\Delta\lambda$) of 200. Each pre-main-sequence star was observed at two grating tilts. Thus, two independent spectra were obtained for each pre-main-sequence star.

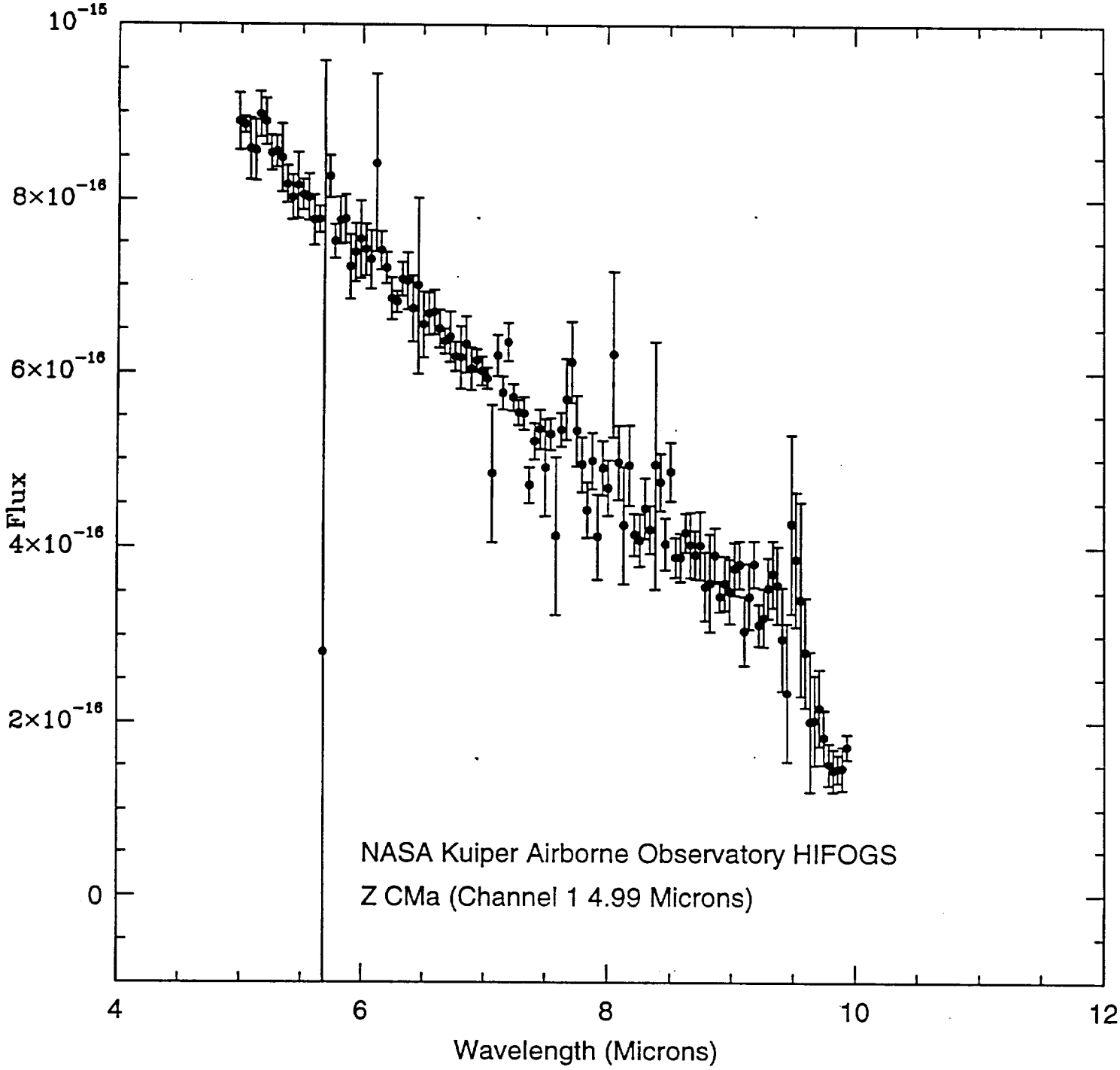
Between January 1992 and September 1993 we carried out the data processing phase of the project. In particular the data was wavelength calibrated and flux calibrated. We present the calibrated spectra in Figures 1 - 8. Our spectra show no conclusive evidence for frozen H_2O and CH_3OH. Our spectra of Z CMa do reveal, however, an unidentified strong emission band at 7.75 μm. The position of this band is near that predicted for PAH molecules.

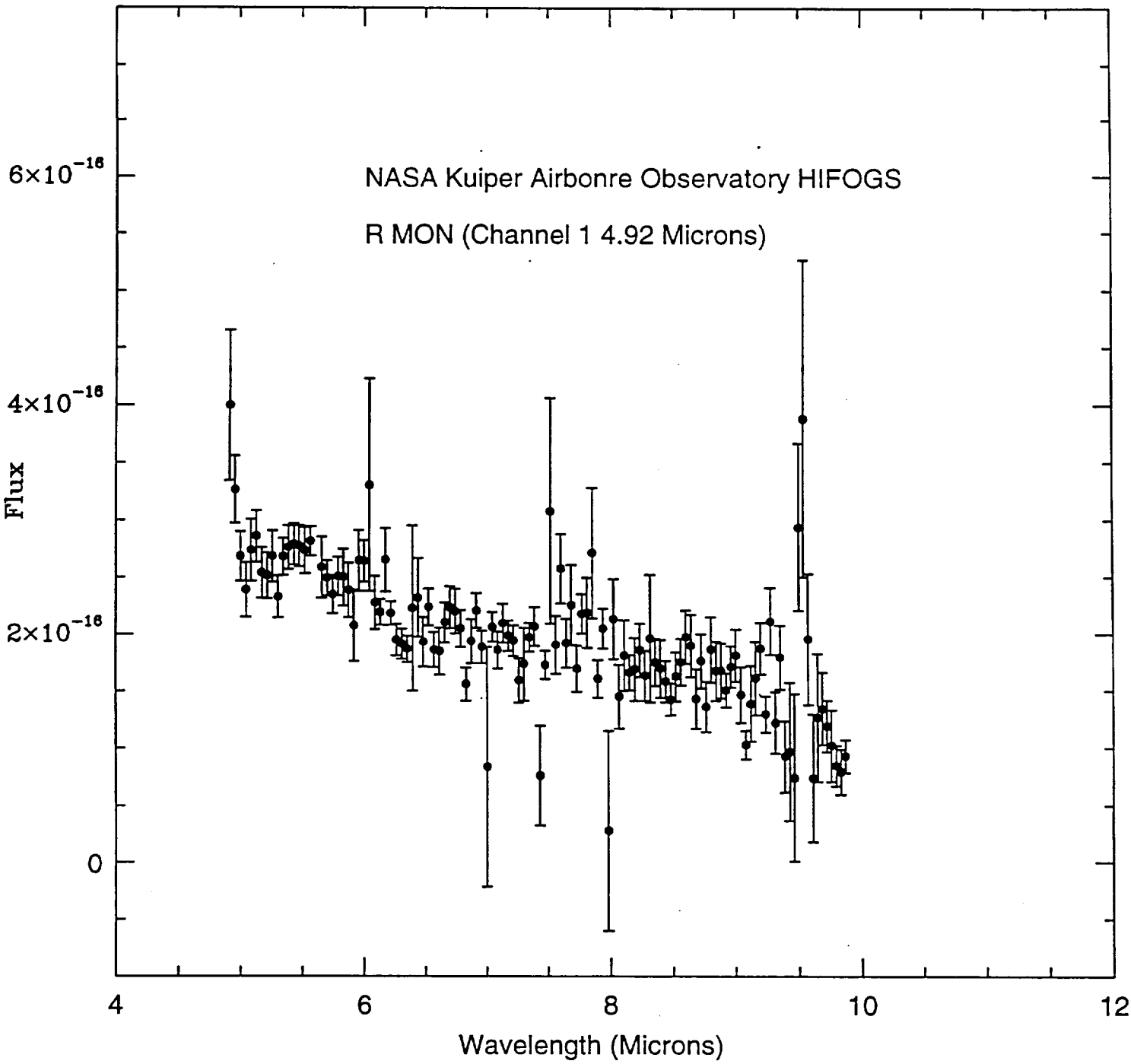
Analysis of our flight data revealed that the noise level of the HIFOGS instrument was 60 % higher than predicted (1 σ error of 0.8 Jy in 30 minutes of integration). As a result HIFOGS was less satisfactory than anticipated in terms of our ability to achieve our scientific goals. Subsequent to our flight, HIFOGS was tested during goundbased observations at Mt. Lemmon and adjusted to reduce the noise level. Thus, the first flight of HIFOGS, though of limited impact scientifically lead to a significant improvement in instrument performance.

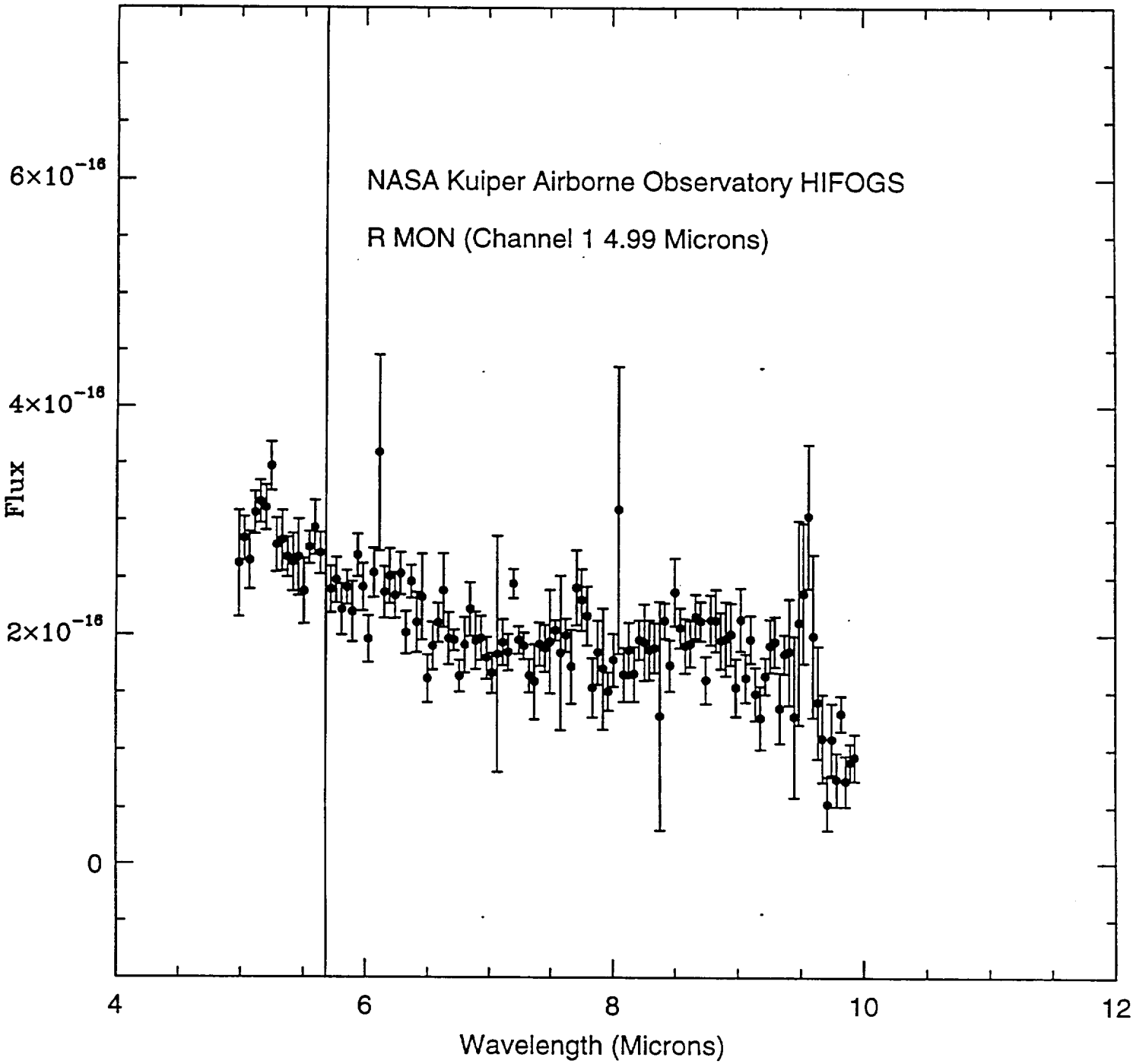

NASA Kuiper Airborne Observatory HIFOGS
MWC1080 (Channel 1 4.93 Microns)
6×10^-16
4×10^-16
2×10^-16
0
Flux
4
6
8
10
12
Wavelength (Microns)

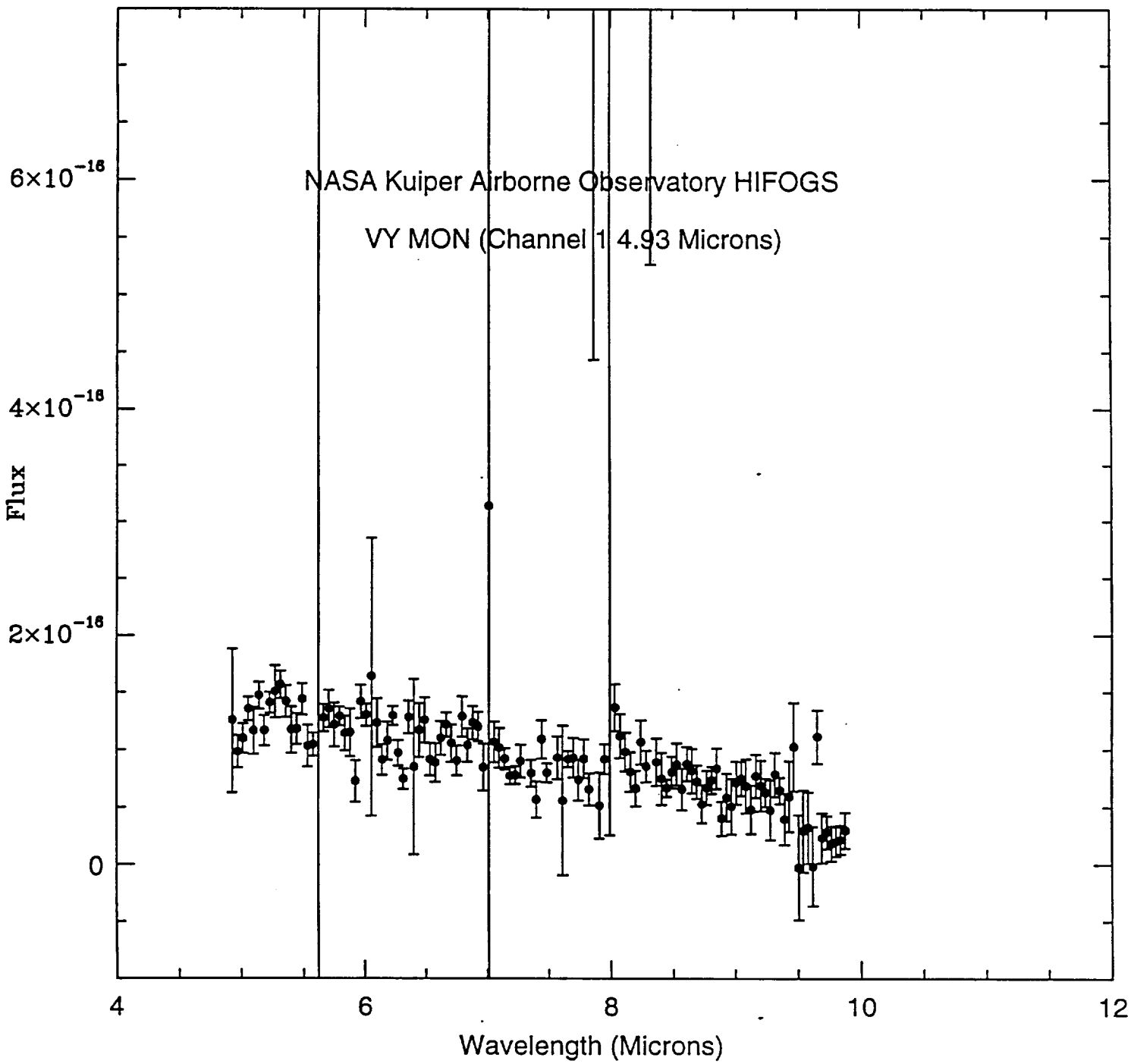

NASA Kuiper Airborne Observatory HIFOGS
MWC 1080 (Channel 1 5.00 Microns)
6×10^-16
4×10^-16
2×10^-16
0
Flux
4
6
8
10
12
Wavelength (Microns)

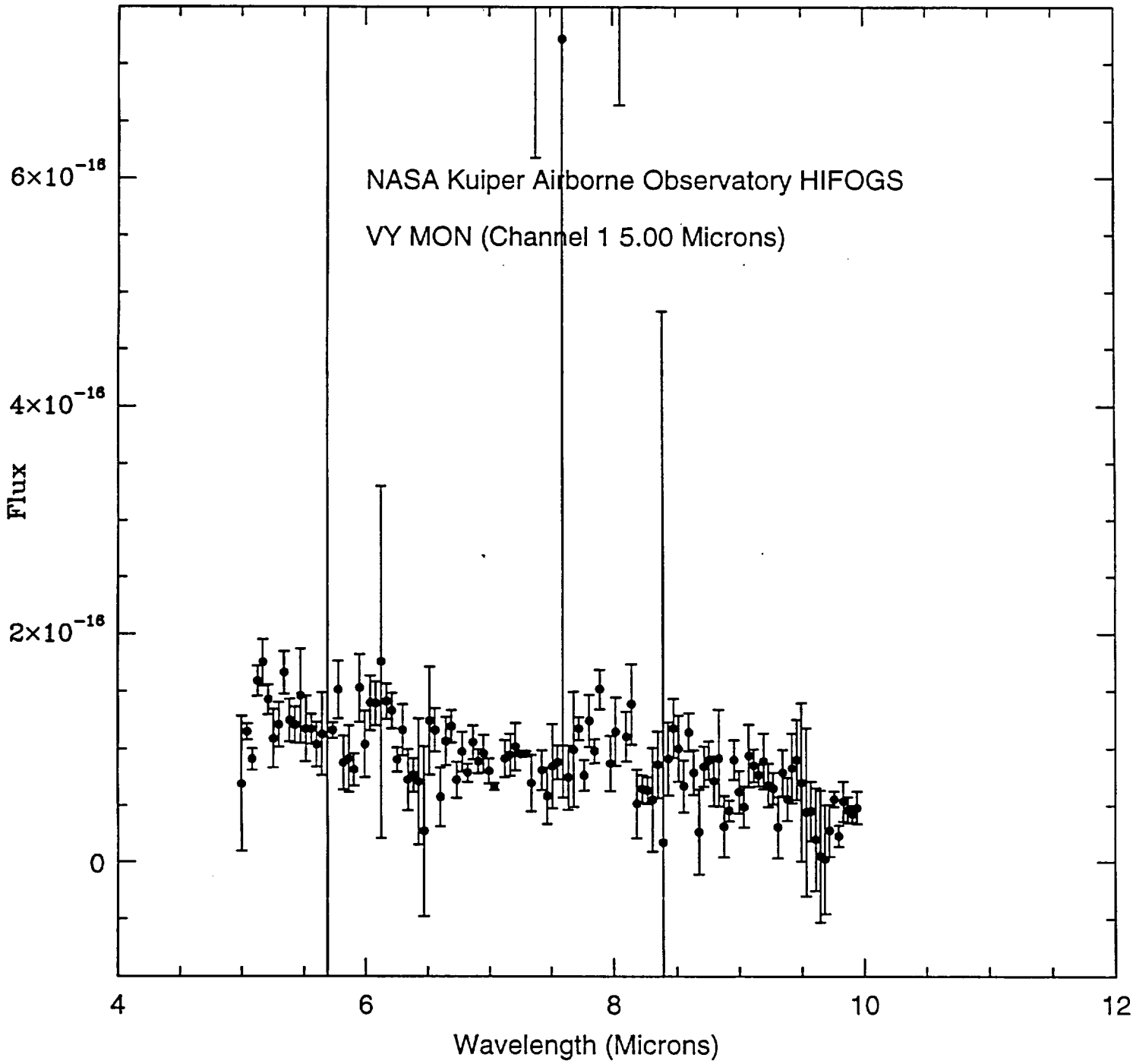

NASA Kuiper Airborne Observatory HIFOGS
Z CMa (Channel 1 4.92 Microns)
Flux
Wavelength (Microns)
10^{-15}
8×10^{-16}
6×10^{-16}
4×10^{-16}
2×10^{-16}
0
4
6
8
10
12


NASA Kuiper Airborne Observatory HIFOGS
Z CMa (Channel 1 4.99 Microns)
Flux
Wavelength (Microns)
10^{-15}
8×10^{-16}
6×10^{-16}
4×10^{-16}
2×10^{-16}
0
4
6
8
10
12


NASA Kuiper Airbonre Observatory HIFOGS
R MON (Channel 1 4.92 Microns)
6×10^-16
4×10^-16
2×10^-16
0
Flux
4
6
8
10
12
Wavelength (Microns)


NASA Kuiper Airborne Observatory HIFOGS
R MON (Channel 1 4.99 Microns)
6×10^-16
4×10^-16
2×10^-16
0
Flux
4
6
8
10
12
Wavelength (Microns)


NASA Kuiper Airborne Observatory HIFOGS
VY MON (Channel 1 4.93 Microns)
Flux
6×10^-16
4×10^-16
2×10^-16
0
4
6
8
10
12
Wavelength (Microns)


NASA Kuiper Airborne Observatory HIFOGS
VY MON (Channel 1 5.00 Microns)
6×10^-16
4×10^-16
2×10^-16
0
Flux
4
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8
10
12
Wavelength (Microns)