The Final Report due December 31, 1971

on Contract NASW 1977

for Research Entitled

"Ultraviolet Investigations of Cosmic X-Ray Sources and Analogous Objects"

by the Principal Investigator

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I. Summary of Provision of Data

The original period of performance was 24 November 1969 through 23 November 1970. This was ultimately extended to 31 December 1971 at no additional cost to NASA in order to give the primary OAO-2 investigators more time to furnish data from the WEP (Wisconsin Experiment Package) and SAO (Smithsonian Astrophysical Observatory CELOSCOPE) instruments. The Preliminary Report due 24 May 1970 explained that no data had been received here during the first six months of performance. Subsequently no program-object data have been received from SAO and data have been received from WEP for only some of the program objects.

The full guest-observer program under NASW 1977 included 5 prime objects, the Crab nebula, eta Carinae, HD 148937, CH Cygni, and HD 192163, and 3 more possible objects, BD+14°3341, NGC 5189, and AG Pegasi. WEP has forwarded photometer data of the Crab, HD 192163, and BD+14°3341, as well as such minimal data of eta Carinae as to be uninformative. These data were all received in July 1971. No data of HD 148937, CH Cygni, NGC 5189, or AG Pegasi have been received. It is possible that some data will arrive in 1971 but too late for analysis and inclusion in this report.

II. Summary of Completed Work

All of the provided data of the Crab and HD 192163 have been analyzed for publication in two papers. They are "The UV Spectrum of the Crab Nebula," a contribution for the Symposium on Scientific Results from OAO-2 at Amherst 1971 August 23-24, to appear in a NASA Scientific Publications volume, in press; and "UV and Radiofrequency Observations of Wolf-Rayet Stars," a contribution for the International Astronomical Union Symposium No. 49 in Buenos Aires 1971 August 9-14, to appear in the symposium proceedings, in press. In addition, a paper which included ground-based observations of the object

HD 192163 has been published with acknowledgement to NASW 1977. This is "Radiofrequency Observations of Symmetric Nebulae around Wolf-Rayet Stars and an Of Star" (Johnson 1971). Five copies of a reprint of this publication and five copies of preprints of each of the other above-mentioned papers are separately provided in accordance with Article V of NASW 1977.

III. BD+14°341

The remaining object for which useful data are available is otherwise known as TT Arietis (Kukarkin et al. 1969). It is "SS Cygni-like," the brightest of the known, hot, presumably subluminous variables with slow, apparently irregular fluctuations (Herbig 1965). The General Catalogue of Variable Stars calls it spectral type B, but Williams (1966) has observed the spectrum to be "essentially continuous, with broad, faint emission lines of hydrogen as the only apparent features." Smak and Stepien (1969) report that the "light variations can be resolved into three, apparently independent activities: (1) periodic variations with $P = 0^d.2658$ and an amplitude of about 0.15 mag; (2) quasi-periodic fluctuations with periods between 14 and 20 min and variable amplitude; and (3) small scale, apparently irregular fluctuations (flickering) with a time-scale of the order of 1 min. It is suggested that the star is a hot, subluminous close binary system." According to Smak and Stepien the colors vary between B-V = -0.06 and -0.08 and U-B = -0.92 and -0.97, which they say put the star(s) close to the blackbody line in the two-color diagram with T_{eff} between 15000°K and 16000°K.

The significant OAO-2/WEP-photometer data (one run) reduce to the result of Table 1, wherein the last column gives the base-10 logarithm of the relative flux per unit frequency interval, which may be compared with blackbody radiation in accordance with the preceding discussion. The galactic latitude of BD+14°341, $b = -43°.8$, fortunately frees us from the probability of having to

Table 1

WEP-Photometer Data of BD+14°341

Filter	λ_{eff}	$1/\lambda$	2 log $1/\lambda$	log I_λ	log I_ν
S1F3	4250 A	2.35 μ^{-1}	0.74	-0.189	+0.03
1	3320	3.01	0.96	0	0
4	2980	3.36	1.05	+0.162	+0.07
S2F2	2940	3.40	1.06	+0.123	+0.02
5	2380	4.20	1.25	+0.395	+0.11
1	2040	4.90	1.38	+0.481	+0.06

make significant corrections for interstellar reddening; no corrections are applied. For T_{eff} = 15500°K the blackbody gradient d log $I_\nu / d(1/\lambda)$ is -0.11 micron in the interval 2.7 - 4.6 micron^{-1}. The observed gradient is significantly different from this result. It is about +0.04 micron and corresponds to T_{eff} = 21000°K. Peak blackbody flux per unit frequency interval is at 3290 A (T = 15500°K) or 2430 A (T = 21000°K), but the blackbody spectral curvature is smaller than the data errors.

The conclusion is that the object radiates neither like an ordinary photosphere nor like a single blackbody, since the spectral gradient approximates to T_{eff} = 15500°K in the range 3600 - 5500 A (UBV photometry) and to T_{eff} = 21000°K in the range 2100 - 4200 A (OAO-2 photometry). Therefore the double-star hypothesis appears to be confirmed. The ultraviolet broadband data do not signify whether the hotter component has any monochromatic emissions or absorptions since probable errors can hardly be separated from such effects. The question of stellar variability is also left unanswered in the single run of data taking. Unfortunately the similar blackbody-like

stars are still fainter and more difficult to observe (BD+14°341 having been selected as brightest of the lot).

IV. Acknowledgements

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V. References

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