

h.d.

THE TANTALIZING "WOW!" SIGNAL

by John Kraus

Abstract A unique narrow-band signal recorded 15 August 1977 at 1420 MHz has characteristics which suggest possible extraterrestrial intelligent origin. Observational data are presented and discussed.

On August 15, 1977, at 2216 EST (1921 LST) in the course of a routine survey of the "water hole" with the Ohio State University Radio Telescope, a signal was received in channel 2 (1420.3556 MHz) which produced an antenna pattern with a peak of 30 sigmas (30 times noise level). The digital output values are shown in Fig. 1 as 1 sigma bars on the measured antenna pattern of Cygnus A adjusted to the same declination and normalized. The fit is within measurement error. The agreement includes not only the same beamwidth but also the same asymmetry of the main lobe with minor (coma) lobe due to the feed horn displacement to one side of the antenna axis (horn squint). The pattern match indicates that the signal source was moving from east to west at a sidereal rate.

The receiver had 50 channels of 10 kHz bandwidth. Bob Dixon's digital format printed a single character every 12 seconds giving the signal level in standard deviations or sigmas above background. A blank indicated zero level. For levels above 9, the letters of the alphabet, A for 10 to Z for 35 were used.

The digital printout is shown in Fig. 2 with Jerry Ehman's "Wow!" notation which has become the signal's designation. The U of the sequence 6, E, Q, U, J, 5 corresponds to 30 sigmas. At the time the 30 sigma signal was observed in channel 2 there was no significant indication on the analog record, as shown in Fig. 3. The

analog receiver bandwidth was 8 MHz or 800 times the channel bandwidth. Due to averaging, no indication should be expected, especially since the signal bandwidth was probably much less than 10 kHz.

To summarize:

(1) The signal frequency of 1420.3556 MHz was inside the internationally protected 1400-1427 MHz band reserved for HI observations in which "all emissions are prohibited".

(2) The signal was strong, 30 sigmas maximum. It was detected for over one and one-half minutes as it passed through the beam of the radio telescope.

(3) The signal bandwidth was less than 10 kHz.

(4) The agreement with the measured Cygnus A pattern, including asymmetries, indicates that the source was moving at the sidereal rate from east to west. To match this pattern an earth satellite would need to be at translunar distances of millions of kilometers. The asymmetrical pattern, including the coma lobe, rules out west to east, north-south or south-north satellite transits.

(5) The coordinates of the signal are $19^{\text{h}} 22^{\text{m}} 22^{\text{s}} \pm 5^{\text{s}}$ or $19^{\text{h}} 25^{\text{m}} 12^{\text{s}} \pm 5^{\text{s}}$ R.A. and $-27^{\circ} 03' \pm 20'$ Dec. (1950.0) which is about 20° from the center of our galaxy. The signal was intermittent, appearing in only one horn of the dual-horn feed. Since the digital output printed only magnitude at that time, it is not known whether the signal appeared in the E or W horn, resulting in the R.A. ambiguity.

(6) The signal direction was about 5° S of the ecliptic and about 10° S of the moon's orbit. The signal direction was at least 90° from all the planets including Pluto.

(7) With help from NASA the positions of all the known space probes were found to be far from the signal direction. In any case, a probe seems unlikely since an active one should have been reobserved near the same coordinates.

(8) The signal location was reobserved over 30 times during the six weeks following its detection and many times in later years with nothing significant being observed. Robert H. Gray of Chicago has had a continuing fascination with the "Wow!" signal and has reobserved its location repeatedly with Prof. Paul Horowitz's Harvard telescope and megachannel receiver with negative results.

(9) Not only has the "Wow!" signal not been reobserved but no other signal like it has been detected in all the years of our sky surveys.

(10) The "Wow!" signal is highly suggestive of extraterrestrial intelligent origin but little more can be said until it returns for further study.

My article, "We Wait and Wonder" in the Summer 1978 issue of COSMIC SEARCH*, gave a general summary of the signal and the circumstances of its detection. Those involved were Dr. Robert Dixon, the driving force behind our SETI efforts, Prof. Jerry Ehman, who did the data analysis, and ^{Dr.} Richard Arnold, who helped part-time. Gene Mikesell and Edward Teiga operated the antenna and receivers with great skill. We also owe a debt to William Brundage, now at N.R.A.O. Socorro, for bringing the receiver system to its maximum efficiency before he left.

*John Kraus, "We Wait and Wonder", COSMIC SEARCH, vol. 1, no. 3, 1978, pp. 31-34.

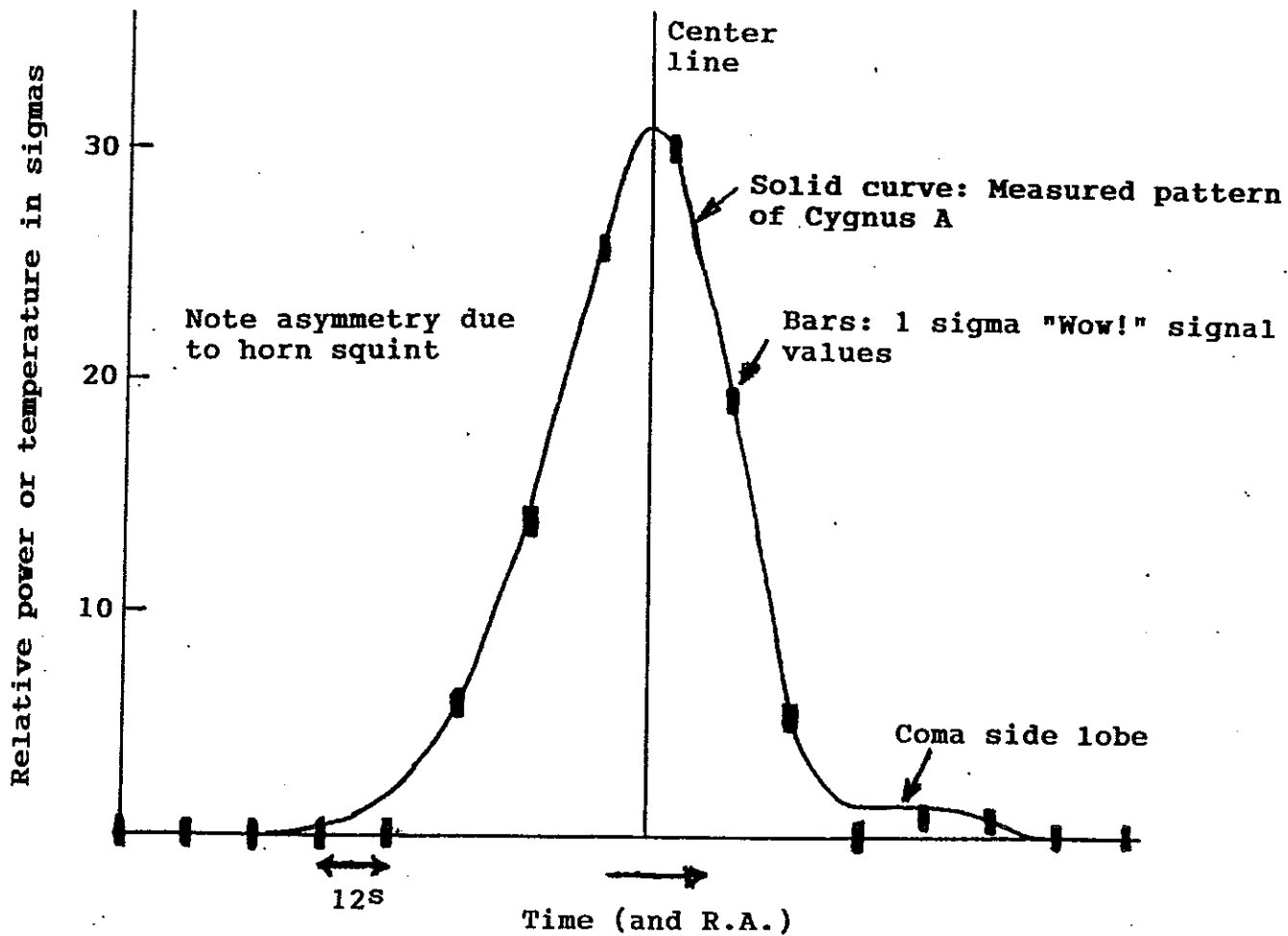
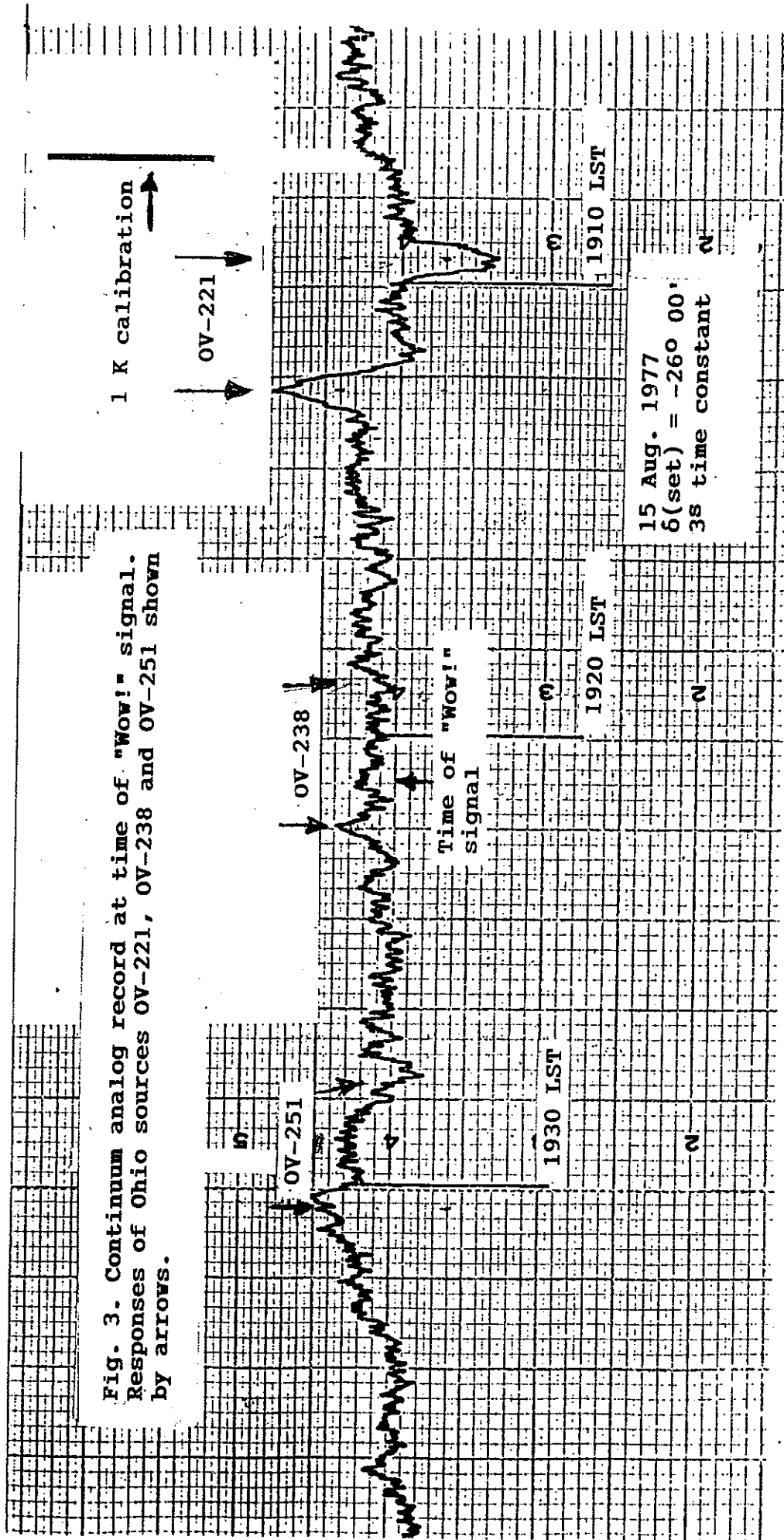


Fig. 1. The "Wow!" signal (bars) compared with measured pattern of Cygnus A adjusted to same declination and normalized (solid curve).

Fig. 3. Continuum analog record at time of "Wow!" signal. Responses of Ohio sources OV-221, OV-238 and OV-251 shown by arrows.



$$T_{s/4} = \frac{100}{\sqrt{10^{4.12}}} \approx \frac{3K}{\sqrt{10^{4.12}}} = 6 \text{ Veff (OV)}$$

$$\frac{100}{\sqrt{8 \times 10^6 \times 3}} = .022K \text{ analog for } 300 \text{ or } 10^6 \text{ Hz bw}$$

Reduction for 10 kHz signal on analog

$$\frac{10^4}{\sqrt{8 \times 10^6}} = .035 \text{ or } .022K \text{ for } 300 \text{ or } 10^6 \text{ Hz bw}$$

FIGURE CAPTIONS

Fig. 1. The "Wow!" signals (bars) compared with measured pattern of Cygnus A adjusted to same declination and normalized (solid curve).

Fig. 2. Digital printout with "Wow!" signal in channel 2.

Fig. 3. Continuum analog record at time of "Wow!" signal. Responses of Ohio sources OV-221, OV-238 and OV-251 are shown by arrows.

The Ohio State University Radio Observatory

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31 Jan. 1994

Dr. Carl Sagan
Cornell University

Dear Carl:

Bob Dixon reports that at the recent "intermittant signals" meeting you expressed a desire to know more about the "Wow!" signal.

I have dredged my archives and enclose herewith a summary that may be of interest.

All best wishes,

John Kraus
Director