The Hale-Bopp Comet and Its Controversial Tale

Build the Cosmic Crystal Set and listen in!

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April 1997 marks the closest approach of the long-awaited Hale-Bopp comet, discovered on July 22, 1995 by amateur astronomers Alan Hale and Thomas Bopp. Although comets are notoriously unpredictable, this one shows every sign of becoming a bright, naked-eye object, perhaps even visible in the daytime! At the very least, the arrival of Hale-Bopp will be an event to remember.

Brightness, however, may not be the most interesting aspect of this object. Riding with Hale-Bopp is an intense storm of rumors and controversy which seems to intensify in direct proportion to the comet's proximity.

The first indication that Hale-Bopp was an "unusual" comet was its discovery: most comets are discovered only a few months away from their closest approach to the sun. The comet Kohoutek set a record in 1973, first seen seven months out. Hale-Bopp was first spotted an incredible 21 months away from Earth, an astounding 666 million miles out, beyond the orbit of Saturn! No comet ever discovered would be visible at that distance, even through the largest telescopes in the world. Hale-Bopp, however, was large and bright enough to be seen by *two* amateurs on the *same night... by accident!* Since the discovery, astronomers have searched old photographic plates and discovered that one shows the (then undiscovered) comet, an astonishing 40 *months* away!

"Hams, known to wear hats sprouting antennas, don't embarrass easily, so in this case it's clearly up to us."

Not only does Hale-Bopp appear to be the largest and brightest comet ever discovered, but its behavior defies explanation. The comet is far brighter than it should be at that distance from the sun, and it has regular outbursts of brightness, accompanied by huge jets of gas, dumping carbon dioxide at the rate of several tons per second. These outbursts occur every 19 days.

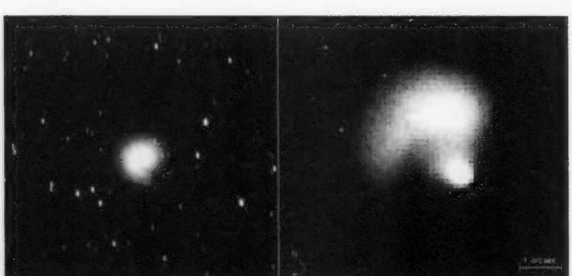

***Photo A.** The HaleBopp comet as seen by the Hubble space telescope on September 26, 1995.*

The controversy surrounding Hale-Bopp really began to heat up on November 16, 1996. Chuck Shramek, radio host and amateur astronomer, released a photograph of the comet which clearly showed a large object moving with Hale-Bopp. This object was round and sharp, with a curious "line" through it that made it resemble the planet Saturn with the rings on edge. The image soon found its way onto the Internet, and all "Hale" broke loose!

Chuck was immediately and savagely attacked and denounced by astronomers everywhere, who claimed that the object in question was an 8.5 magnitude star, and the "line" was a diffraction spike caused by the optics in Shramek's telescope. The object in the photograph, however, was clearly brighter than magnitude 8.5, since it was at least as bright as the 4th magnitude Hale-Bopp... and Chuck's telescope does not have a secondary mirror support, and therefore does not create "diffraction spikes" on bright objects. Since that time, other photographs have surfaced from the Japanese National Observatory and others which also show a "companion" traveling with the Hale-Bopp comet.

If Hale-Bopp has a "companion," it would not be that unusual. Most objects in the solar system large enough to have any gravity at all have them. Even the tiny asteroid "Ida" has a companion, a small chunk of rock that orbits the asteroid (although why it was not named "Ho" is a great mystery!). Why, then, does the "Hale-Bopp companion" spark so much outrage and denial among astronomers?

Maybe it's the radio signals!

That's right, radio signals! Starting about the same time as Shramek's photo controversy, rumors of RF emissions

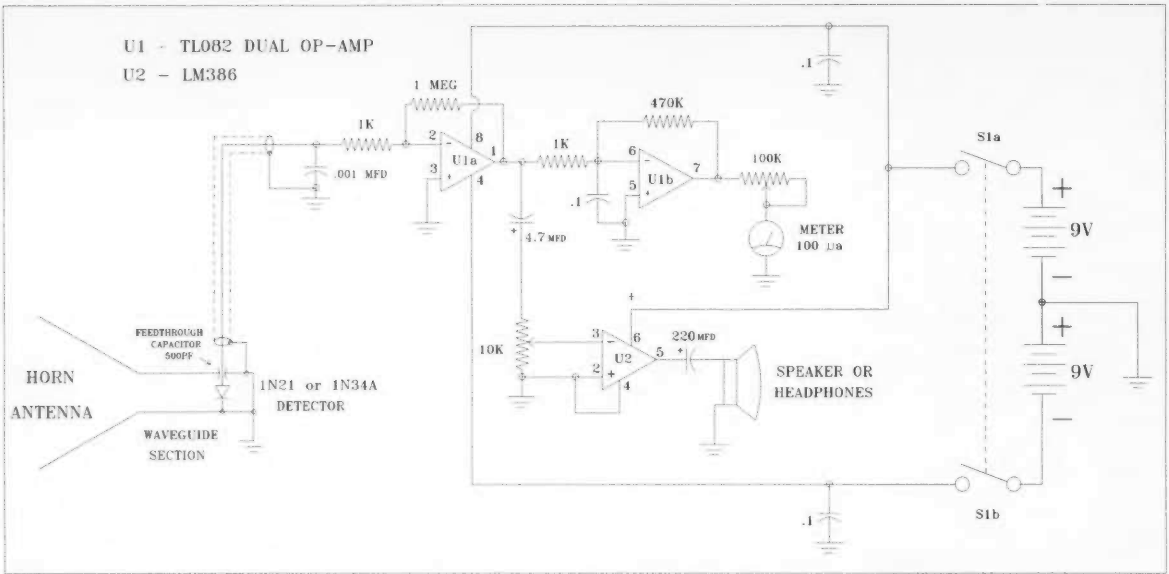

Fig. 1. Schematic diagram for the Cosmic Crystal Set. A sensitive diode detects the microwave signals that enter the waveguide.

from Hale-Bopp began to surface. Some of these emissions were broadband, clearly natural "noise," but others were reported as narrowband, high-intensity signals... *modulated* signals! Radio talk show host (and ham) Art Bell played a tape of one of these signals on the air, and added that a professional astronomer (who did not want his name mentioned) confirmed the reception of "unambiguous signals," not from the comet, but from the *companion!*

As you might expect, this announcement brought the controversy to a new level. Theories to explain the signals began to fly, ranging from some natural-but-unexplained byproduct of the intense gas jets to advanced extraterrestrial beings. Astronomers have refused to comment on the signals at all.

Friends, no professional scientist is going to touch this one, and we can't blame them. Scientists live in a political world, and their livelihoods depend on credibility—and funding. The mere mention of a phenomenon tainted with rumors of "giant spacecraft" and "little green men" assures that they will ignore it. It's a sad fact that, should some E.T. someday fly by and send us some sort of greeting in passing, we might never know, since the professionals would be too embarrassed to acknowledge it!

Hams, known to wear hats sprouting antennas, don't embarrass easily, so in this case it's clearly up to us. Best-selling author Whitley Strieber commented, on the Art Bell show, that hams should monitor Hale-Bopp for radio activity, just as amateur astronomers are observing it optically. I fully agree; whether there are E.T.s involved or not, Hale-Bopp is the most unusual visitor to the inner solar system in our lifetime, and won't return for 3,600 years. We won't get a second chance. Besides, it's a challenge right up our alley, and it sounds like fun!

The "Cosmic Crystal Set"

There has been very little technical information to go along with the Hale-Bopp signal rumors. There have been several references to "K-Band," which only narrows it down to 24 billion possible frequencies. We can, however, make some assumptions: *If* these signals are from intelligent beings, and *if* they are intended for us, then it's safe to assume that they will be easy to receive.

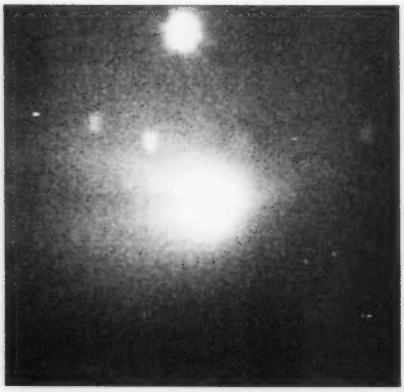

Photo B. *Is this a hoax? This photo, from an anonymous source on the Internet, shows the Hale-Bopp comet with its purported companion.*

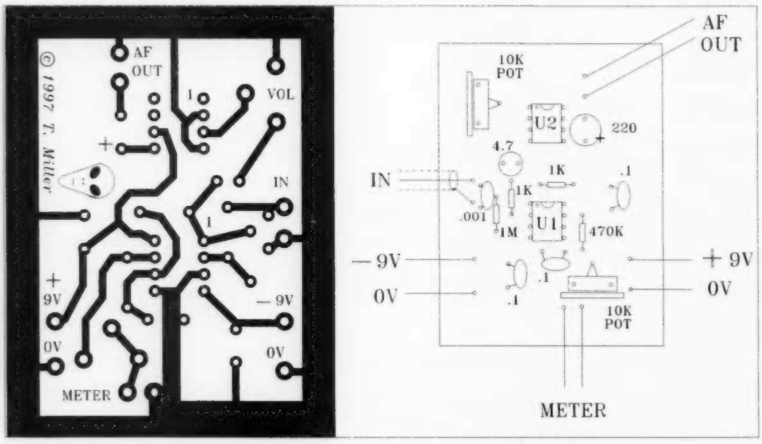

Fig. 2. Printed circuit board pattern and component layout guide for the Cosmic Crystal Set.

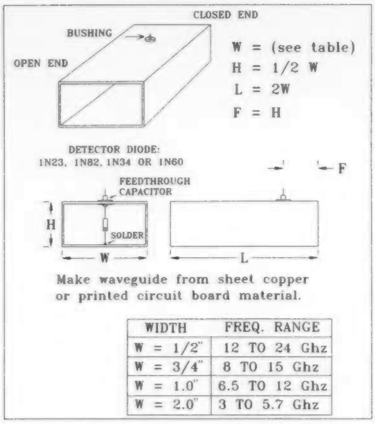

Fig. 3. Waveguide and crystal diode detector construction details.

They would also probably utilize microwave frequencies where antennas behave much like optics, making efficient, tightly focused transmissions possible. Given that, K-Band doesn't sound like a bad choice, but there's no reason not to listen to the entire microwave spectrum, and perhaps UHF and VHF as well. A voltage-tuned TV tuner can sweep from 54 to 800 MHz, and, with the IF displayed on an oscilloscope, makes a sensitive spectrum analyzer. TVRO systems could be used, using the baseband video output to drive a good HF receiver. Surplus radar detectors have sensitive superhet front ends for both X- and K-Band. All these things can, and should, be used—but what if you don't have access to any equipment at all? No problem. You *build* something!

Fig. 1 shows the schematic diagram of the "Cosmic Crystal Set." This simple microwave receiver is nothing more than a sensitive germanium diode detector in a short section of rectangular waveguide. The diode rectifies the microwave energy which is bypassed for RF by a small ceramic feedthrough capacitor. The resultant DC (and audio, if the signal is modulated) is passed to the input of the amplifier.

The amplifier uses a TL082 dual op-amp for two stages of DC-coupled gain. The first stage amplifies the incoming signal, and the second serves as a meter driver. The 100-microamp meter provides an indication of signal strength. If you use a zero-center meter, it won't matter which way you connect the diode across the waveguide.

A 4.7-microfarad capacitor is used to pick off any audio present on the signal, where it is boosted by an LM386 audio amplifier. It can drive headphones or a small speaker. The circuit is powered by two 9-volt batteries.

Fig. 2 shows the printed circuit board and parts layout for the amplifier. The parts are available from Radio Shack™, as well as any good electronic supply house. If there is any interest, I can provide circuit boards for those who can't make their own.

When completed, this device is actually a very sensitive field-strength meter. The only frequency-selective component is the waveguide itself. **Fig. 3** shows the construction of the waveguide, which can be made from sheet brass, copper, or tin. Printed circuit board material works well, also.

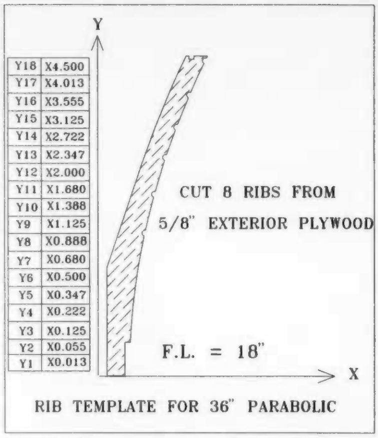

Fig. 4. Rib pattern for the three-foot-diameter parabolic dish. The focal length is 18 inches.

A waveguide is actually a high-pass filter. The cutoff is the point where the wavelength is equal to the width of the guide. Waves shorter than half the guide's width will pass through as well, but the mode of propagation is uncertain, so waveguides are selected in different widths for various bands of frequencies. The table at the bottom of **Fig. 3** shows the proper waveguide width for the different microwave bands. All other dimensions are scaled to this width, as shown. By building one amplifier and a number of waveguide/detectors, it is possible to monitor virtually the entire microwave spectrum.

These waveguides will receive signals of only one polarization, so some method of rotating the horn 90 degrees should be employed to catch both horizontal and vertical signals.

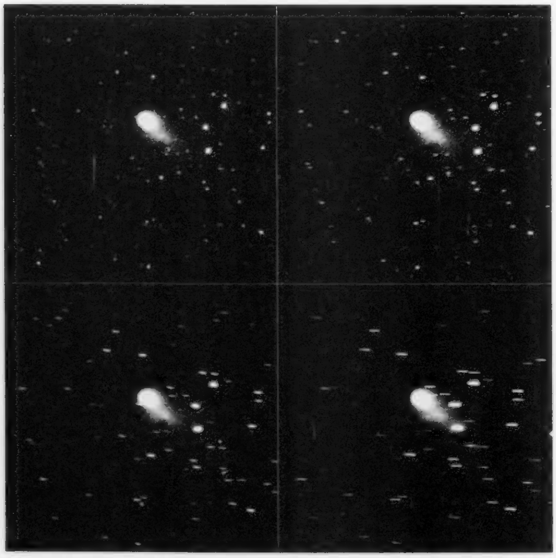

***Photo C**. The Hubble telescope captures the Hale-Bopp as it hurtles toward our solar system.*

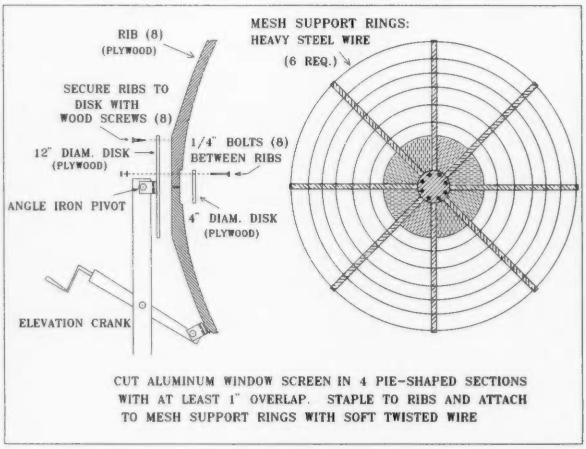

Fig. 5. Construction details of the three-foot dish. The framework is covered with aluminum window screen.

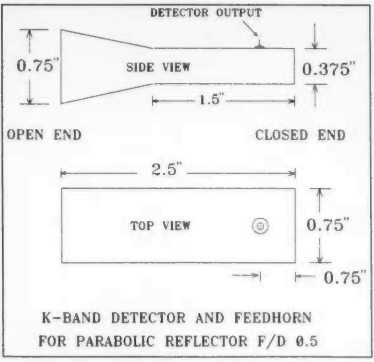

Fig. 6. *Dimensions for the K-Band detector and feedhorn. This feed will work with other dishes with a focal ratio of 0.5 to 0.7.*

Home-brew microwave antennas

Since diodes have loss, we have to offset this with antenna gain. The most popular microwave antenna is the parabolic reflector. A dish in the 2- to 4-foot range should be ideal for K-Band signals; anything larger would have too narrow a beamwidth to be of much use. **Fig. 4** shows a rib template for a 3-foot parabolic reflector with a focal distance of 18 inches. You can scale this drawing up directly, or lay out your own pattern by plotting the X and Y coordinates from the table and connecting the dots.

Fig. 5 shows how the ribs are assembled to form the antenna framework. The ribs are mounted on a 12-inch plywood disk, while a 4-inch disk is mounted in front. Through-bolts hold the two disks together, providing a strong support for the ribs. I've used this technique for quite a number of antennas, the largest measuring 12 feet.

The feedhorn is shown in **Fig. 6**. Essentially the same as the waveguide/detector shown in **Fig. 3**, the waveguide is extended an inch, while the narrow dimension is flared to match the 3/4-inch width, providing a square aperture. The diode is mounted half a guidewidth from the shorted end. The dimensions shown are for K-Band signals, but can be scaled for other bands.

Sometimes surplus dishes turn up surprisingly cheap, and most often the focal distance of these dishes is very short, making them hard to feed with a conventional horn. **Fig. 7** shows a simple way around this problem: Rather than flaring the waveguide into a horn, the corners of the open end are trimmed back at an angle and a "dispersal pin" is added in the center of the opening. I've used this to feed dishes with F/D ratios as small as .25 with great success. The beamwidth will vary somewhat with the angle, but 20 degrees seems to work pretty well. For K-Band, a piece of 14-gauge wire will work for the dispersal pin; make it thicker at lower frequencies.

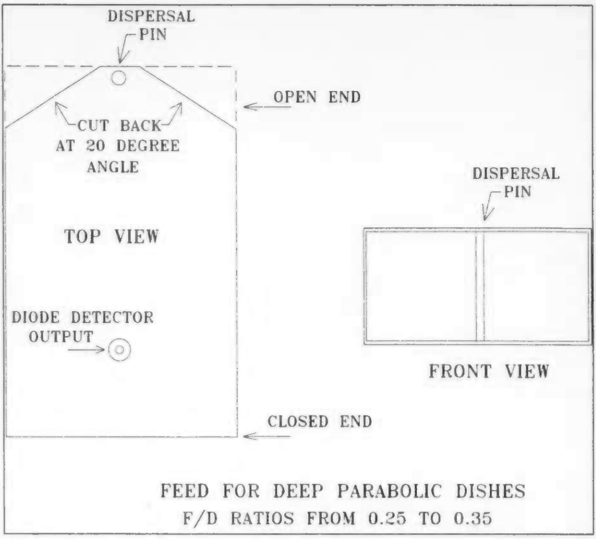

Fig. 7. By trimming the open end of the waveguide as shown, short-focal-length surplus dishes can be easily fed.

All right, you don't have a parabolic lying around, and building one takes too long. Now what do we do? **Fig. 8** shows a simple alternative that anyone can make with a yardstick and a pocketknife. It's a "Giant Pyramidal Horn" antenna, and it can be made from aluminum-foil-backed Styrofoam™, available in standard (4- x 8-foot) sheets at any lumberyard or building supply store. In essence, the horn has as much gain as a dish of the same area, so the 12-inch by 14-inch horn shown might be the equivalent to an 18-inch dish. There is no reason, however, why it cannot be made much larger: Just taper the open end smoothly to whatever size waveguide you are using. The foam can be glued with white carpenter's glue and reinforced with toothpicks. The inside corners can be covered with aluminum tape.

Well, there you have it... simple microwave equipment that you can build tonight, and listen to Hale-Bopp on tomorrow! If you hear anything, send me your reports and I'll post them on my web site, The Martian Archives. If you have Internet access (and you should!), you can keep an eye on this site to see what others are hearing. The URL is: http://www.infocom.com/~thomil/

Afterword

Okay, so you built the Cosmic Crystal Set, and Hale-Bopp came and went with nary a sign of Extraterrestrial Biological Entities. Now what?

Well, you might as well keep listening. After all, there are countless microwave signals of all types within reach of the amateur, and no doubt

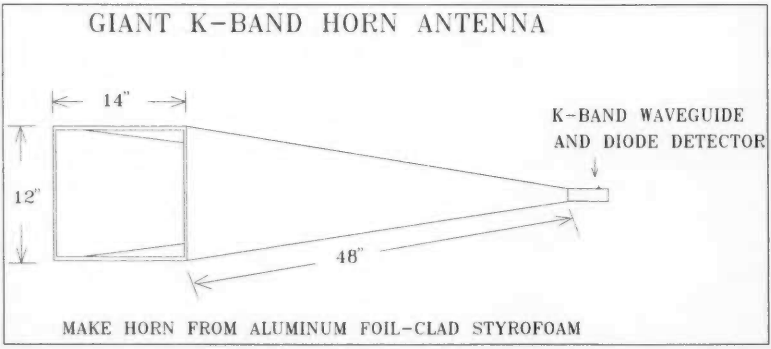

Fig. 8. The giant pyramidal horn is more bulky than a parabolic reflector, but is far less critical and easier to build.

certain people wouldn't enjoy knowing that you are listening to them. What better reason is there for listening? Also, you now have a very sensitive field strength meter—connect a diode across a two-meter dipole and it should make a good sniffer for transmitter hunts. Or, you could connect the coil of an old relay to the input, making a very sensitive magnetic field monitor.

And if the E.T.s didn't send you their greetings *this* time, who knows what will show up tomorrow?

I welcome your comments... send E-mail to thomil@infocom.com. Should you prefer to correspond via disgruntled government employees, please include an SASE.

Internet resources: the World Wide Web

http://www.infocom.com/~thomil/—"The Martian Archives"—This is the author's home page. There is an area devoted to the Hale-Bopp monitoring project.

http://www.stsci.edu/pubinfo/pictures.html —This is the home page of the Hubble Space Telescope. There are Hale-Bopp images here, but nothing new has been posted since early November.

http://newproducts.jpl.nasa.gov/comet/ —NASA's "Hale-Bopp Home Page." Keep in mind that this is from the guys at Never Actually Say Anything... and this is probably the *slowest* web server in the universe.

http://www.neosoft.com/~cshramek/—Home page of Chuck Shramek, who started all the controversy by imaging the "companion."

http://www.strieber.com —Whitley Strieber has devoted an area to late-breaking comet news. Whitley first mentioned using amateur radio operators to monitor Hale-Bopp.

http://www.artbell.com —Home page of Art Bell, amateur radio operator and late-night radio host. Art has a lot of comet information on-line, as well as many other interesting topics.