

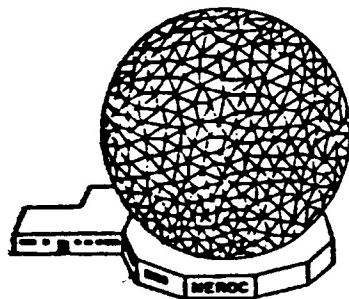
VLA Test Memoranda
No. 151

GLONASS Observations
J. C. Carter

December 04, 1987

**NORTHEAST RADIO OBSERVATORY CORPORATION
HAYSTACK OBSERVATORY
WESTFORD, MASSACHUSETTS 01886**

JULY, 1987
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**OPERATED UNDER AGREEMENT WITH
MASSACHUSETTS INSTITUTE OF TECHNOLOGY**

JULY 1987 SURVEY OF GLONASS SATELLITES

J. C. Carter

On July 6, 7, and 8, 1987, Haystack again observed the Soviet GLONASS satellites for transmissions which could cause interference in the 1610.6 to 1613.8 MHz radio astronomy band. Twenty-seven (27) satellites were observed, out of which ten (10) were found to be active.

A combination of Haystack's satellite radar and radio astronomy capabilities were used. The antenna was pointed by the Long Range Imaging Radar computer, according to initial state vectors from the Millstone Hill satellite catalog, and the radio astronomy L-band cooled FET receiver was used to receive the satellite signals. A Hewlett-Packard 8566A spectrum analyzer was used to process the signals and produce spectra, which were then photographed and also sent to a computer and plotted.

In Table 1, which is a summary of the observations, each satellite is identified by its COSMOS number. The frequency shown is the observed frequency and is not corrected for doppler shift. Signal amplitude is the strength of the signal, at its center frequency, compared with the measured strength of the radio source CASS A. For example, COSMOS 1711 transmitted at 1612.5 MHz and produced a signal 38 db stronger than did CASS A.

For each transmitting satellite, three spectra are shown in Fig. 1 through Fig. 9. The first spectrum, labeled "A", is a double exposed photograph of the spectrum analyzer screen and shows the received signal when the antenna was pointed at the satellite (upper trace) and what was received when the antenna was pointed five degrees off of the satellite (lower trace). The off-source trace best shows the 70 MHz wide receiver bandpass, which is determined by an image rejection filter located between the RF amplifier and the first mixer.

The second spectrum, labeled "B", is a higher resolution computer plot of the received signal and spans 100 MHz with a 100 KHz resolution. Each satellite signal has a narrow center feature less than 1 MHz wide. About 10 db below the center feature is a much broader feature almost 10 MHz wide at its 10 db points.

The third spectrum, labeled "C", spans only 15 Mhz with a 30 kHz resolution to show more detailed structure of the narrow center feature and the narrow features in the first nulls.

Interference appears in some spectra. Some of the lines between 1566 MHz and 1600 MHz are the second harmonics of the video and sound carriers of television Ch. 66 and Ch. 68 in Boston, MA. Other interference features are caused by a nearby powerful 440 MHz ionospheric research radar.

Two of the active satellites, COSMOS 1778 and COSMOS 1779 were too close in sky position to be resolved by the Haystack antenna. Their observed frequencies were 1608.2 MHz and 1613.0 MHz, but we are not able to say which frequency belongs to which satellite.

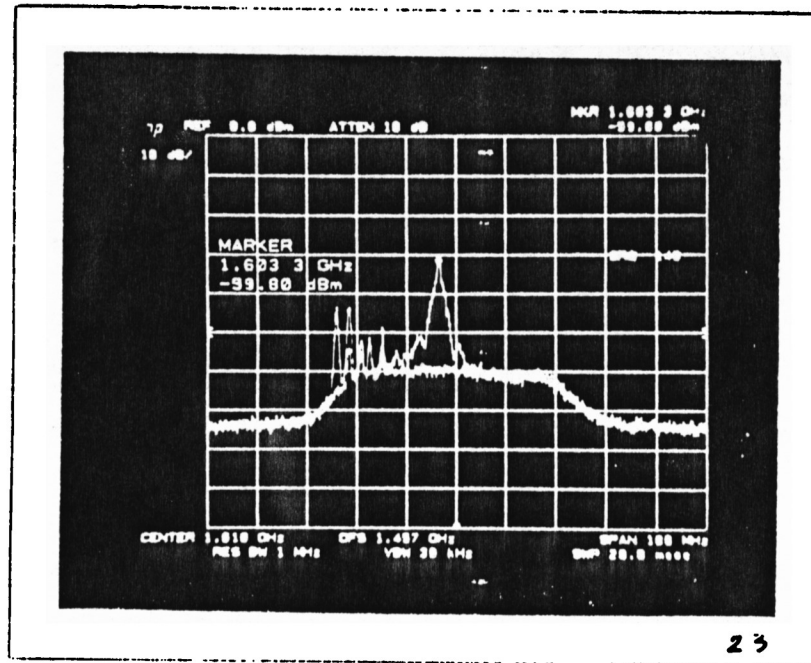
There is some confusion about COSMOS 1555. It was observed on Dec. 4, 1984 at a frequency of 1612.1 MHz. No signal was observed from it during our July 1986 observations, and since only satellites found to be active then were observed during our brief observation period on Feb. 27, 1987, it was not included in that search. Now we find it transmitting at a lower frequency of 1603.0 MHz. It probably did not turn off and then turn on at a different frequency. More likely, during the Dec. 1984 observations its position was confused with another satellite (perhaps COSMOS 1519, then observed at 1603.1 MHz) which has since turned off. In any event, the satellite now called COSMOS 1555 transmits near 1603.0 MHz.

TABLE NO. 1

SUMMARY OF JULY, 1987 GLONASS SATELLITE OBSERVATIONS						
COSMOS NUMBER	FREQUENCY (MHz)	AMPLITUDE (db. Above CASS A)	OBSERVATION TIME AND POSITION (for "A" spectra)			
			DATE	TIME (UT)	AZIMUTH	ELEVATION
1490	1603.6	27	7/7/87	1255	229	28
1554	1607.3	37	7/6/87	1910	257	15
1555	1603.0	30	7/6/87	1928	313	61
1593	1607.3	33	7/6/87	1945	80	26
1650	1606.0	36	7/6/87	2000	25	13
1710	1604.0	40	7/6/87	2014	334	60
1711	1612.5	38	7/6/87	1838	345	68
1778/1779 *	1608.2/1613.0 *	37	7/6/87	2025	63	33
1780	1614.5	36	7/6/87	1805	25	9

* 1778 and 1779 have the same sky position. Unable to tell which frequency belongs to which satellite.

No signals were observed for the following satellites:
 COSMOS 1413, 1414, 1415, 1491, 1492, 1519, 1520, 1521, 1556, 1594, 1595,
 1651, 1652, 1712, 1838, 1839, 1840



Center Freq. = 1610 MHz
 Freq. Span = 180 MHz

Figure 1A

COSMOS 1490

Spectrum A

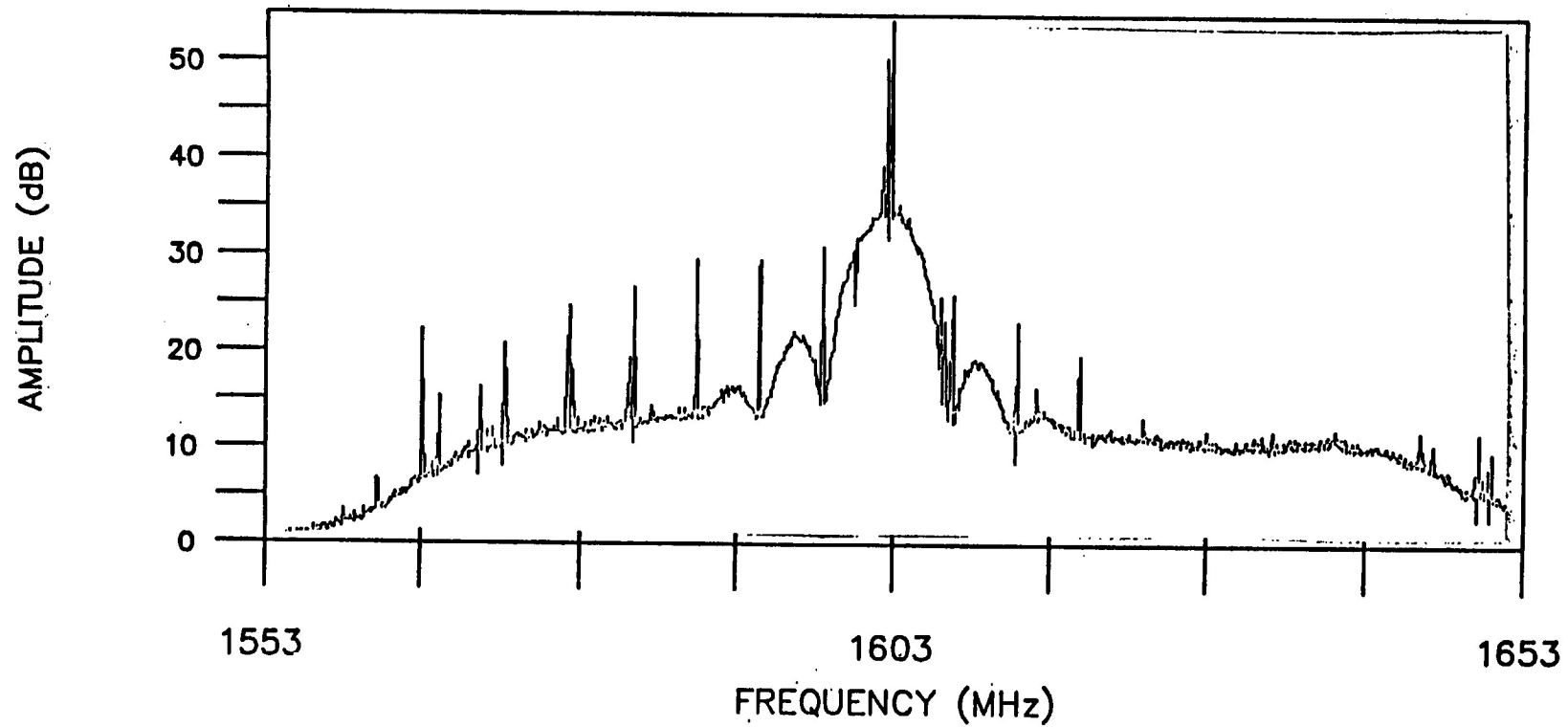


Figure 1B

COSMOS 1490

Spectrum B

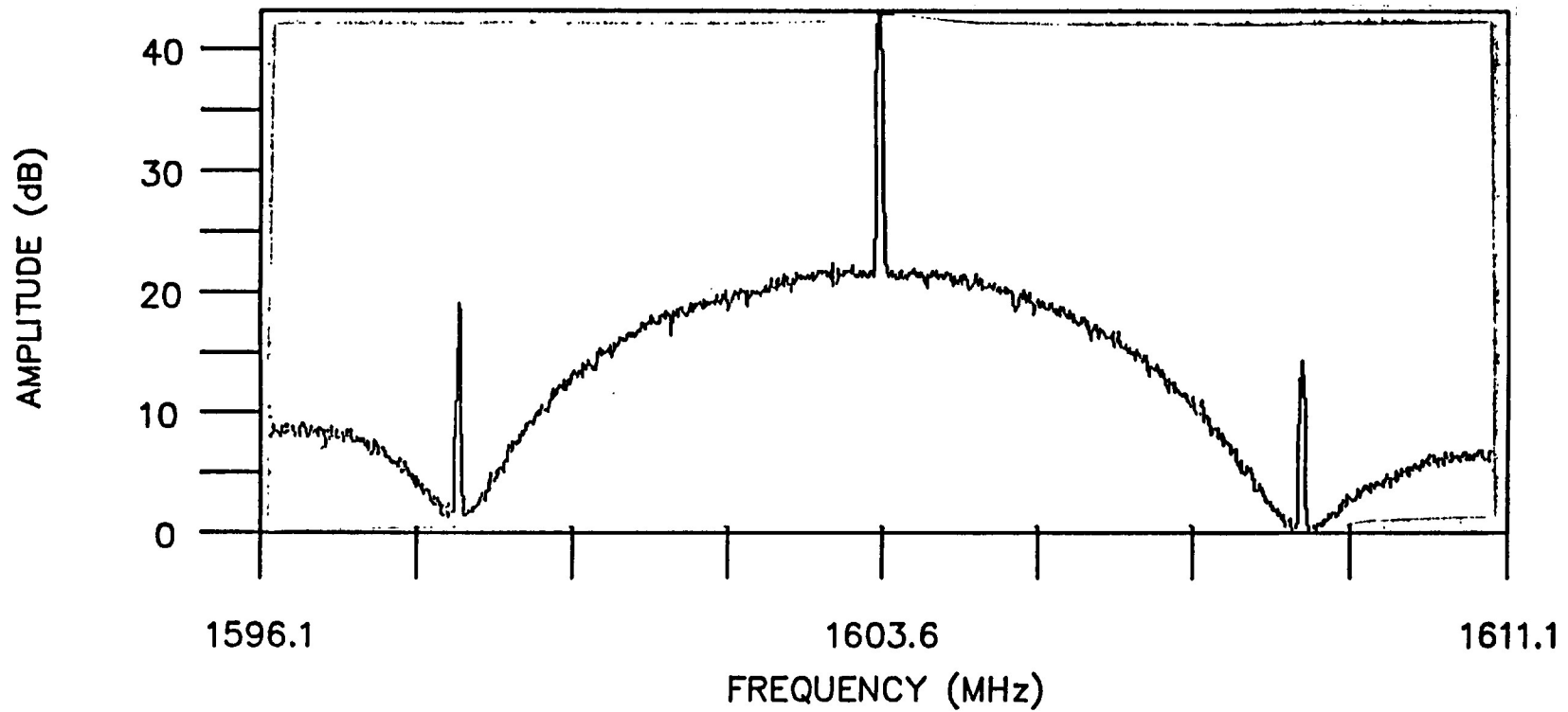
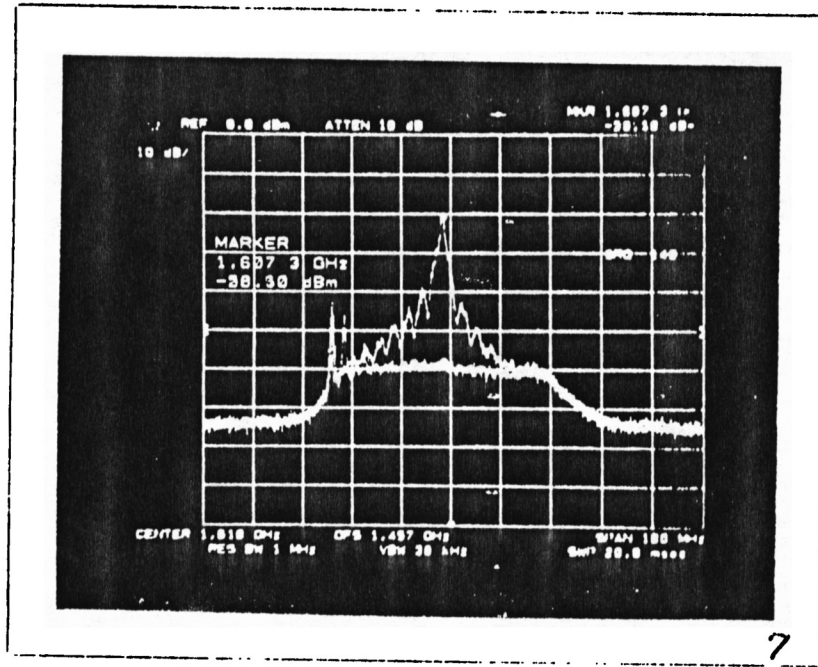


Figure 1C

COSMOS 1490

Spectrum C



Center Freq. = 1610 MHz
 Freq. Span = 180 MHz

Figure 2A

COSMOS 1554

Spectrum A

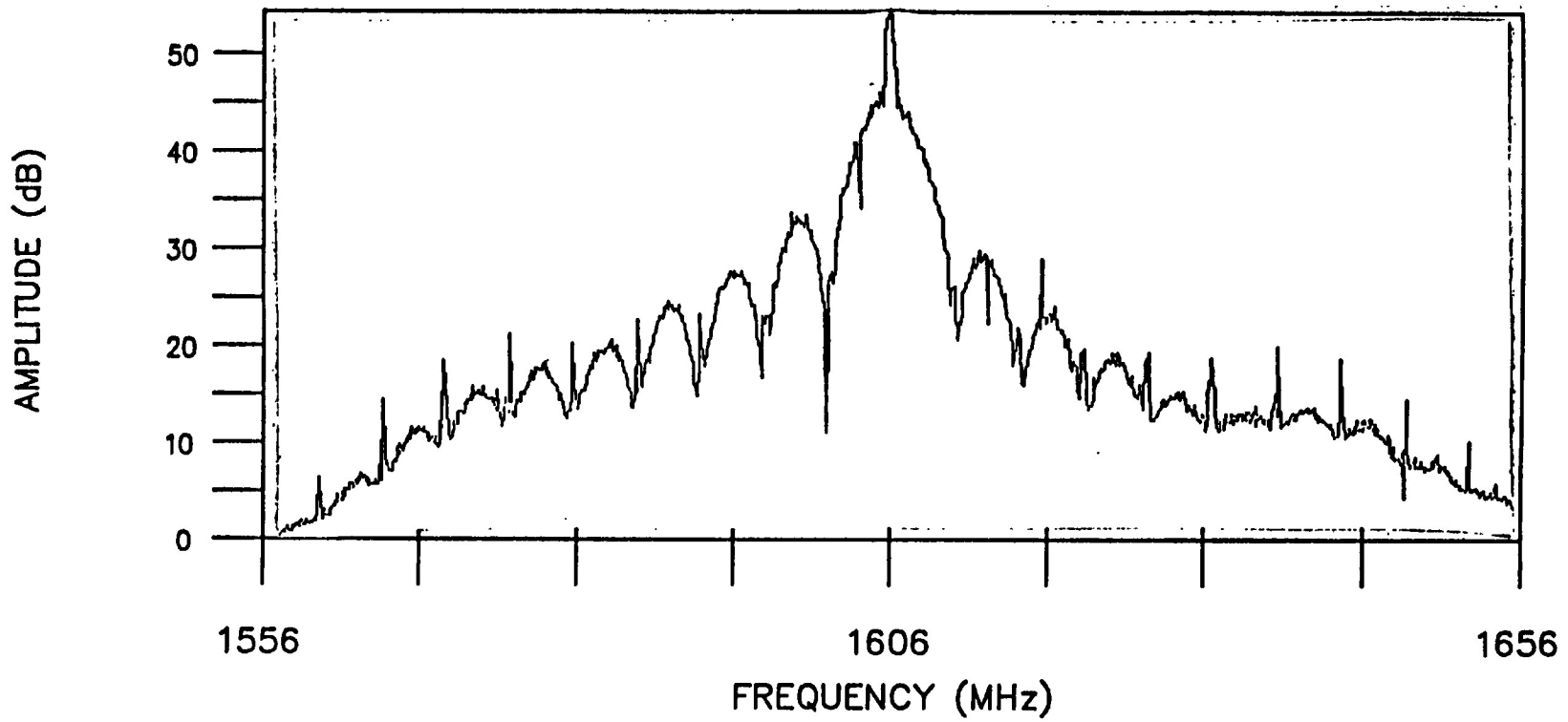


Figure 2B

COSMOS 1554

Spectrum B

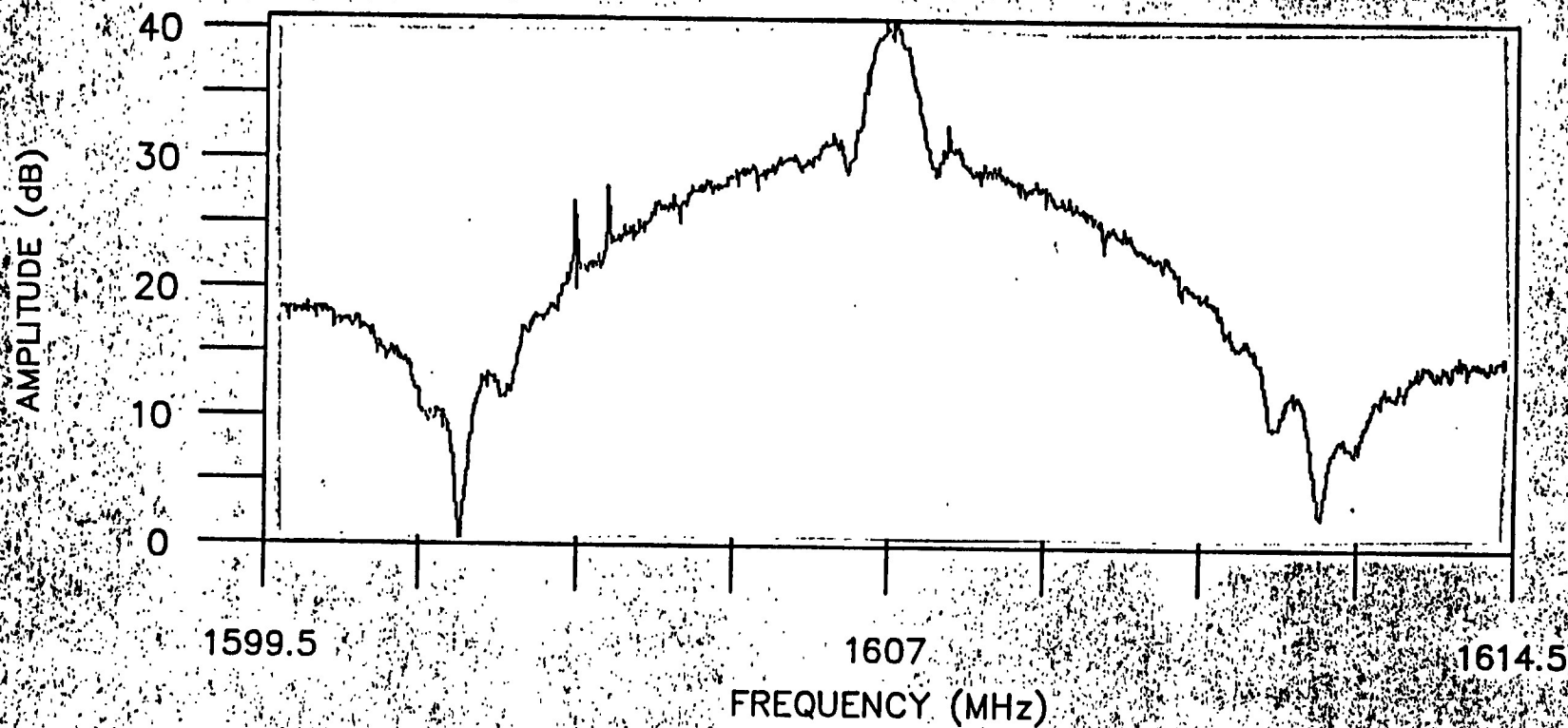
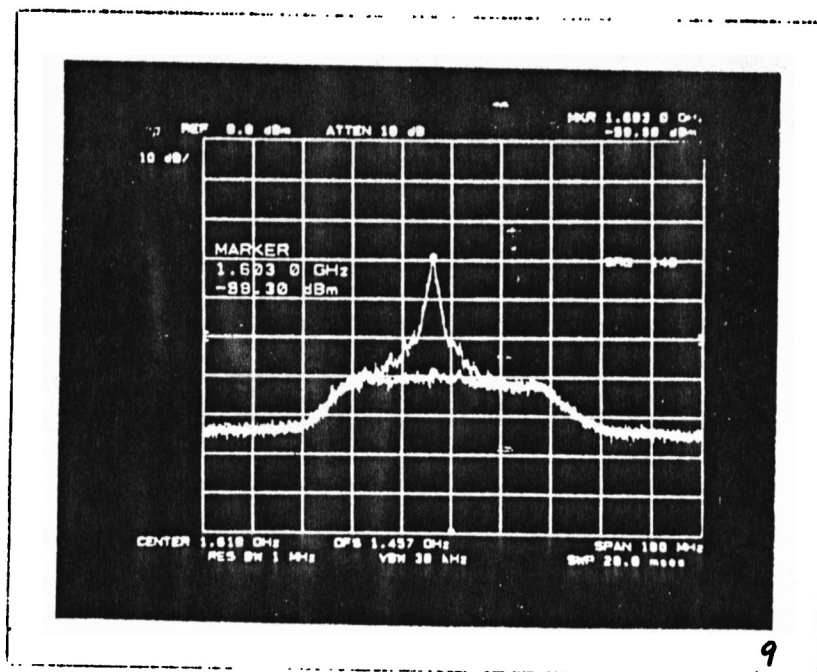


Figure 2C

COSMOS 1554

Spectrum C



Center Freq. = 1610 MHz
 Freq. Span = 180 MHz

Figure 3A

COSMOS 1555

Spectrum A

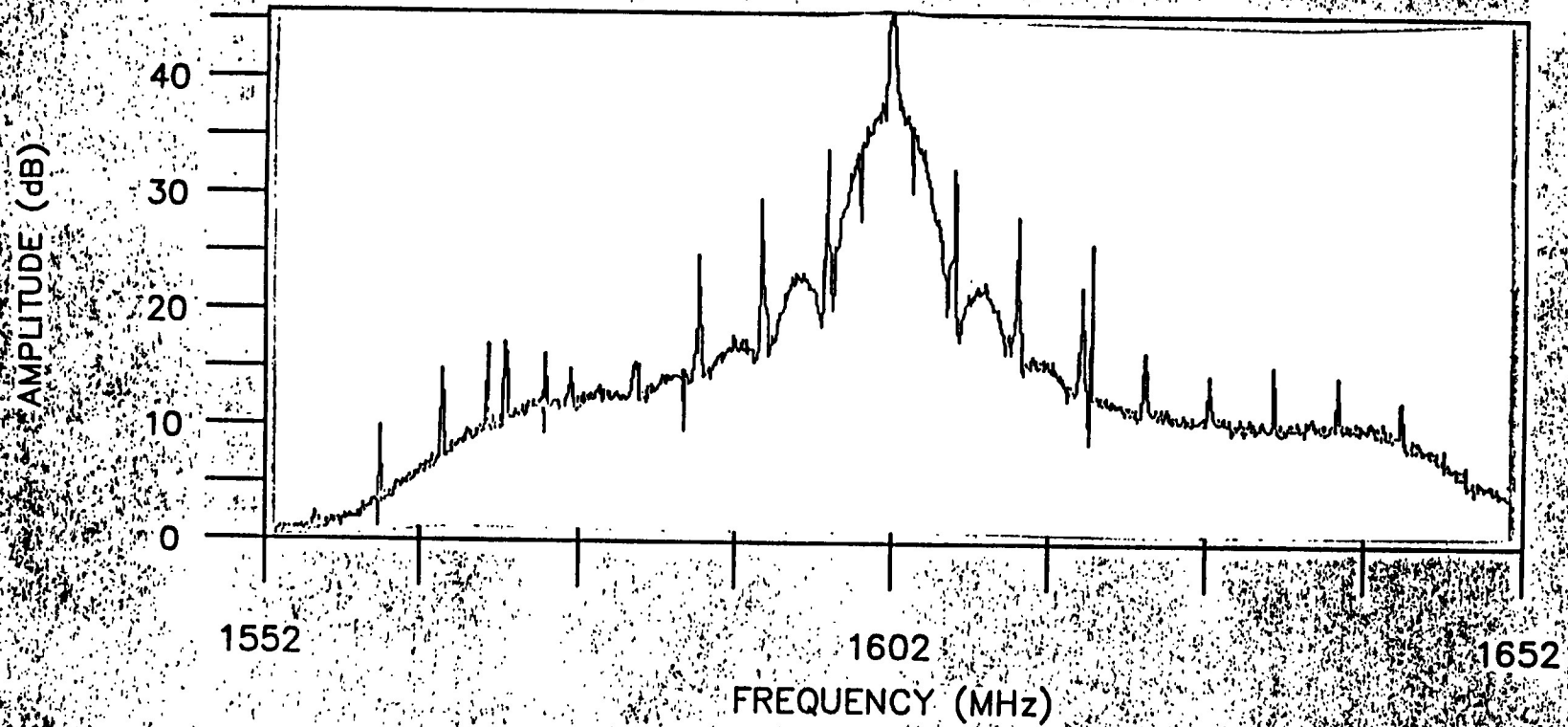


Figure 3B

COSMOS 1555

Spectrum B

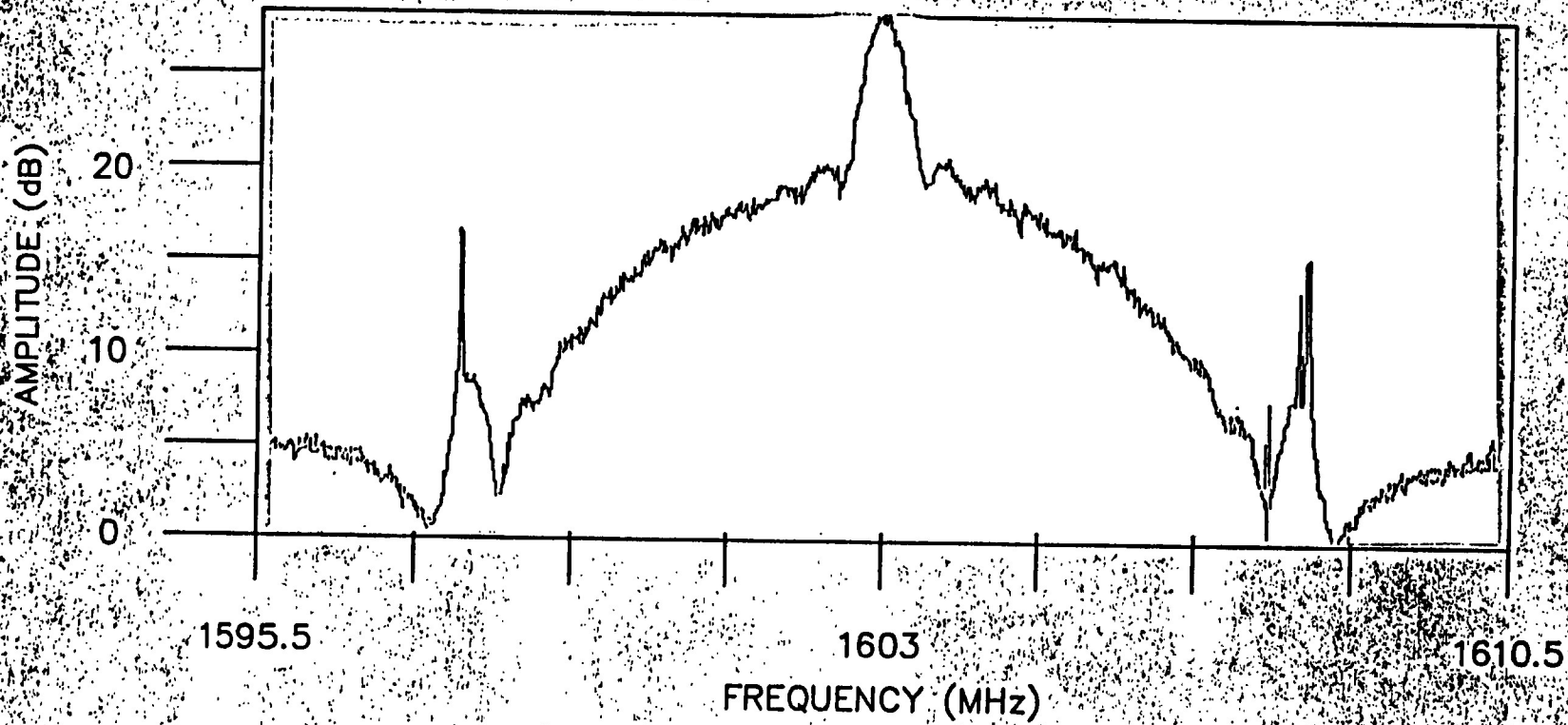
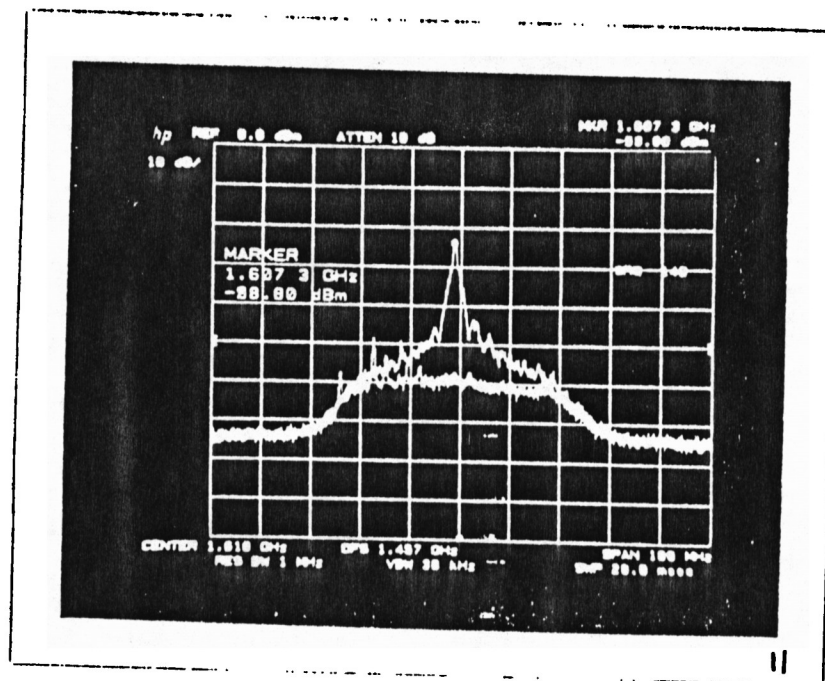


Figure 3C

COSMOS 1555

Spectrum C



Center Freq. = 1610 MHz
 Freq. Span = 180 Mhz

Figure 4A

COSMOS 1593

Spectrum A

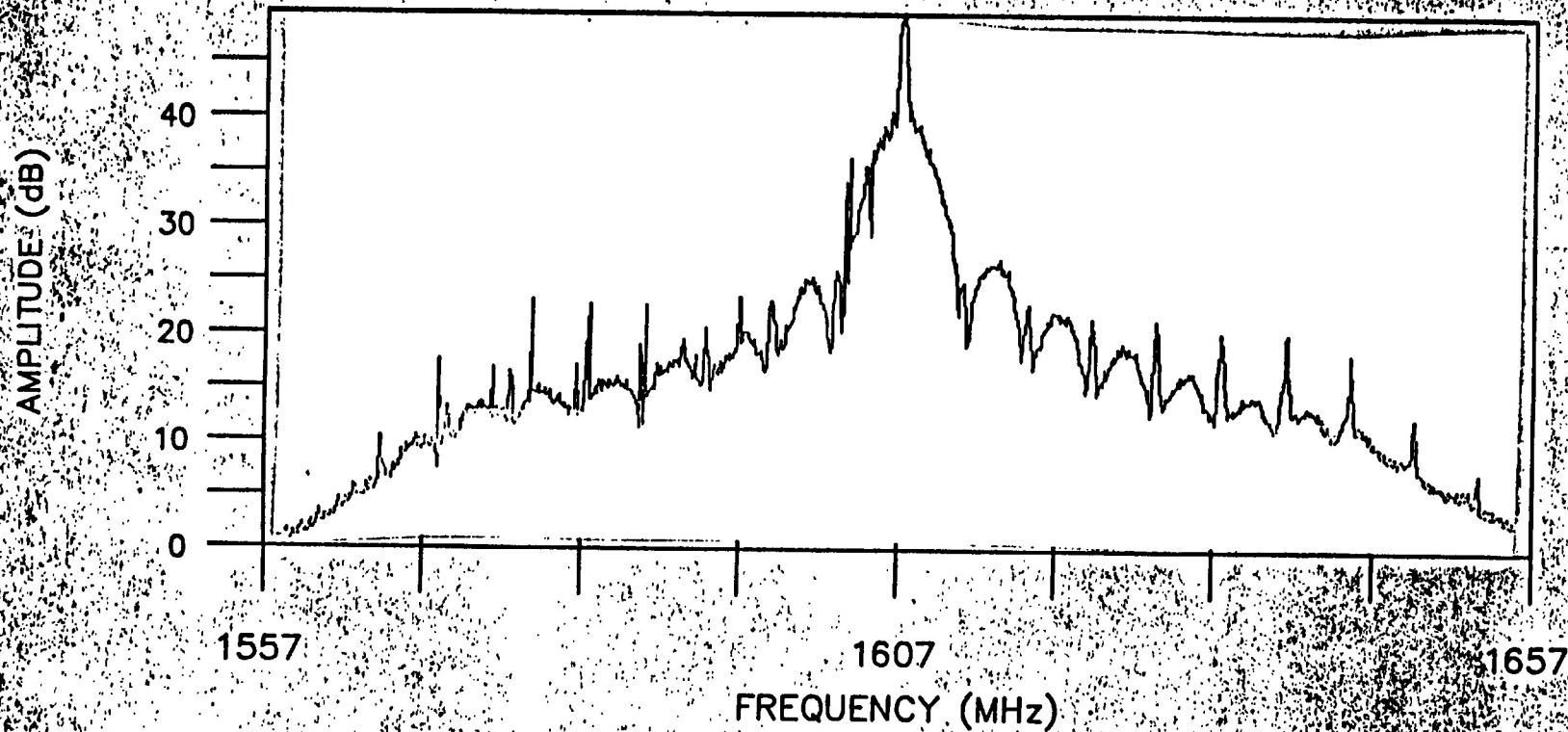
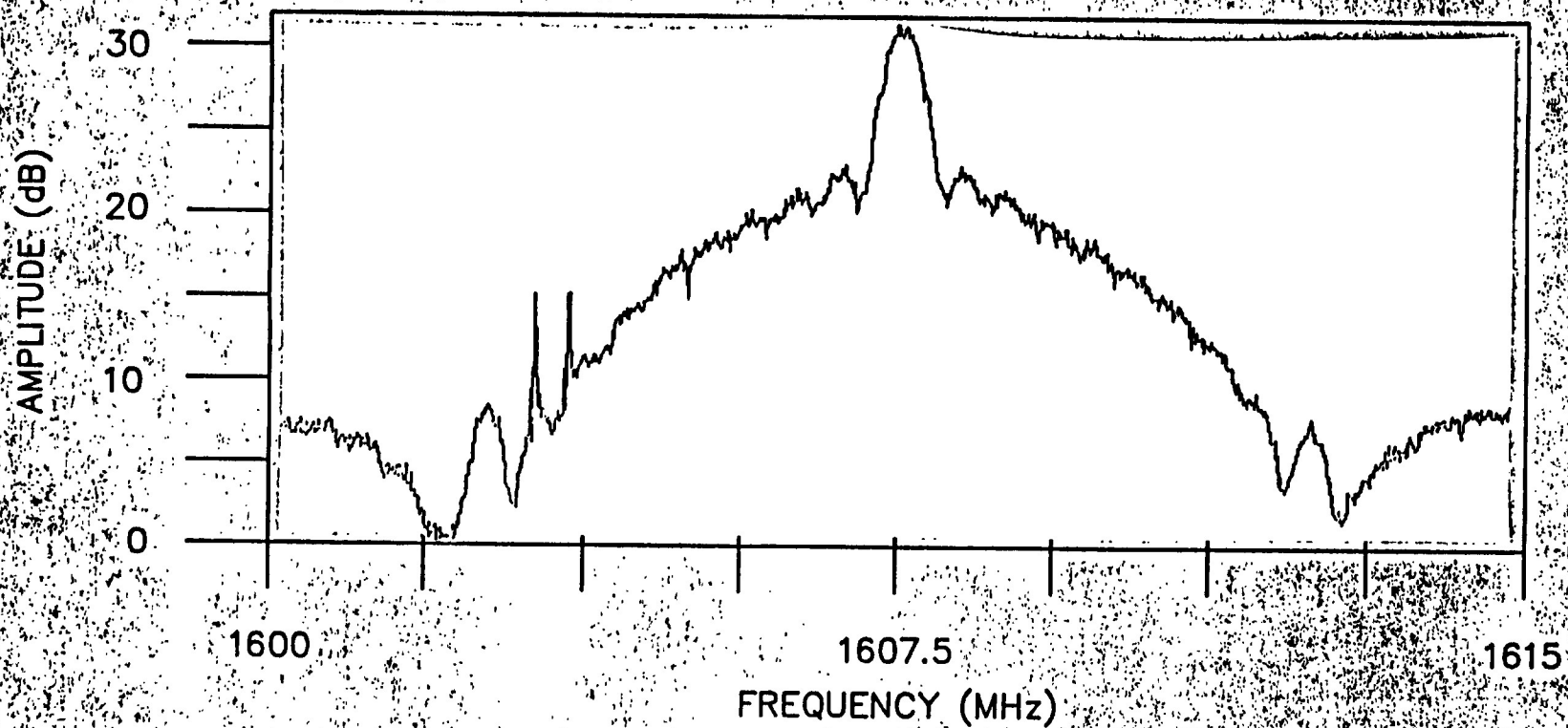


Figure 4B

COSMOS 1593

Spectrum B

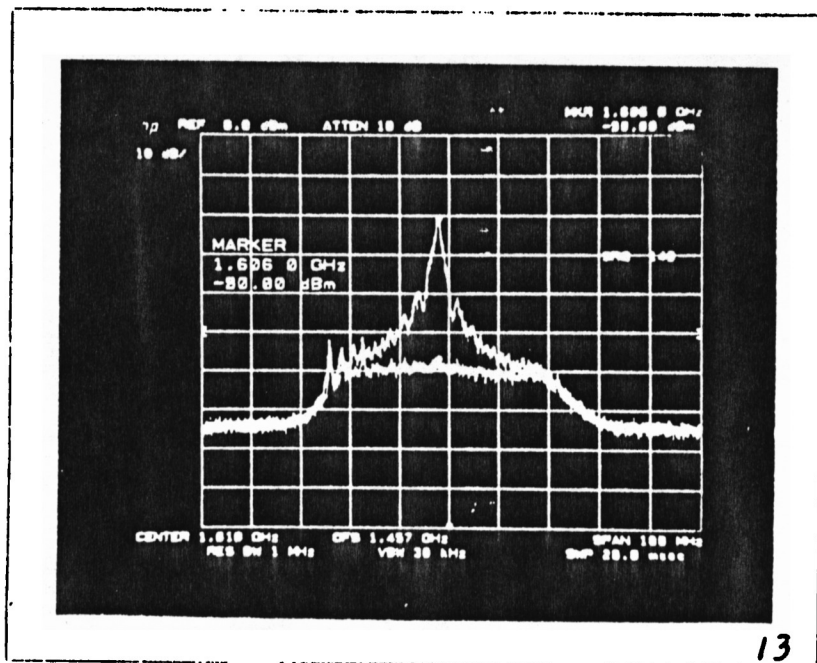


NOTE: The two sharp features near the left null are interference.

Figure 4C

COSMOS 1593

Spectrum C



Center Freq. = 1610 MHz
Freq. Span = 180 MHz

Figure 5A

COSMOS 1650

Spectrum A

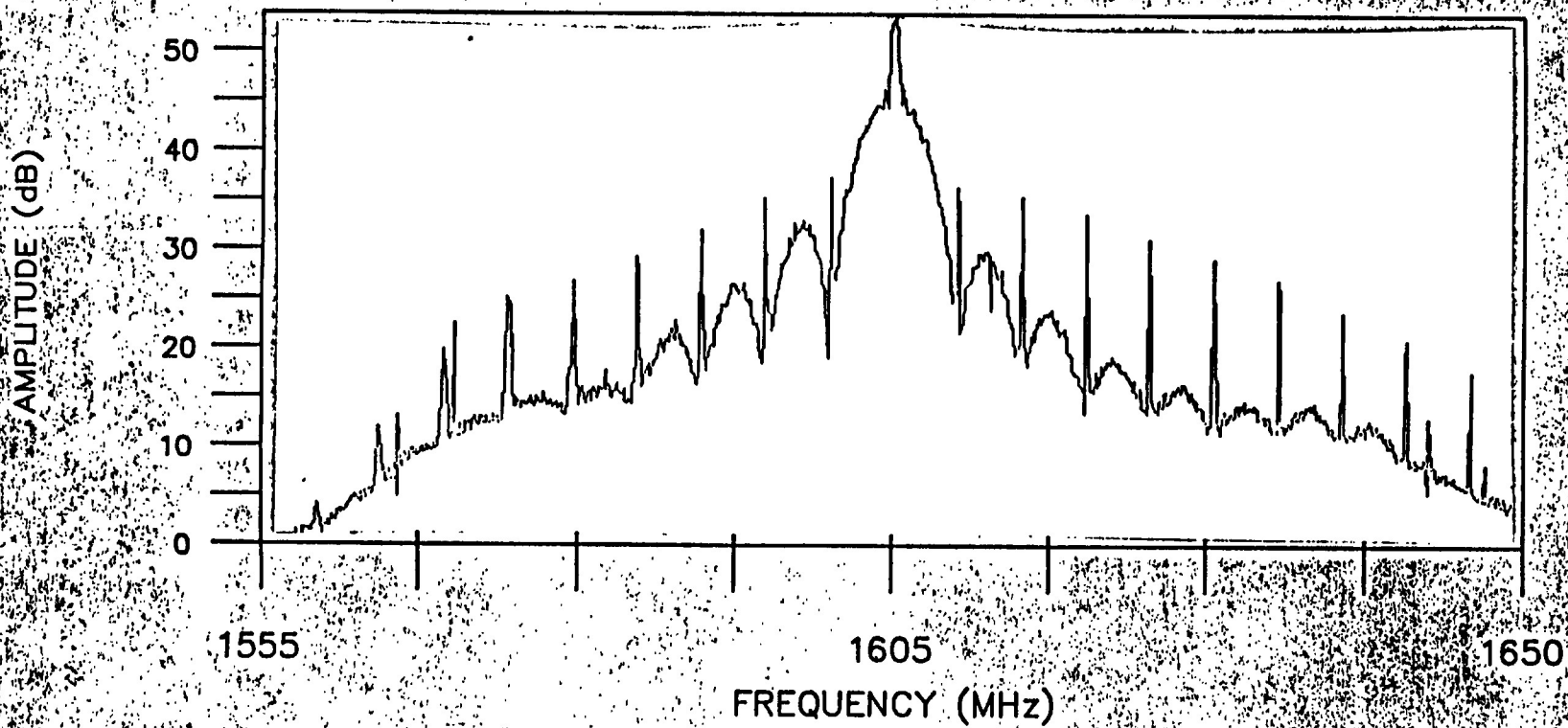


Figure 5B

COSMOS 1650

Spectrum B

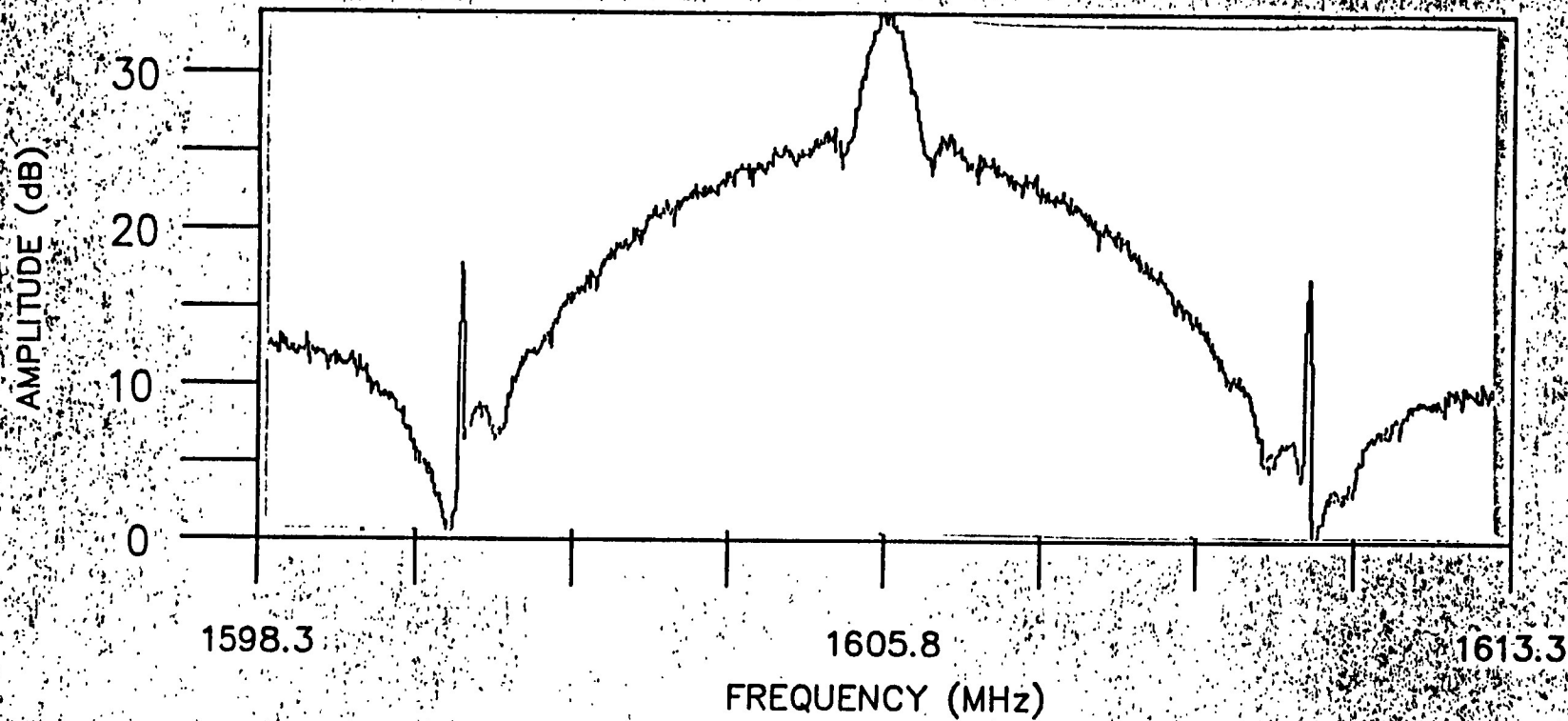
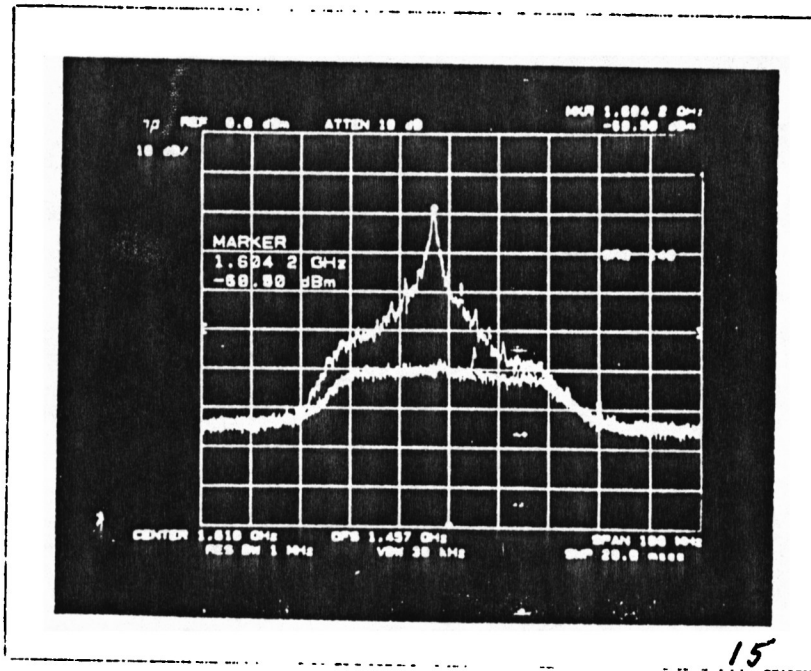


Figure 5C

COSMOS 1650

Spectrum C



Center Freq. = 1610 MHz
 Freq. Span = 180 MHz

Figure 6A

COSMOS 1710

Spectrum A

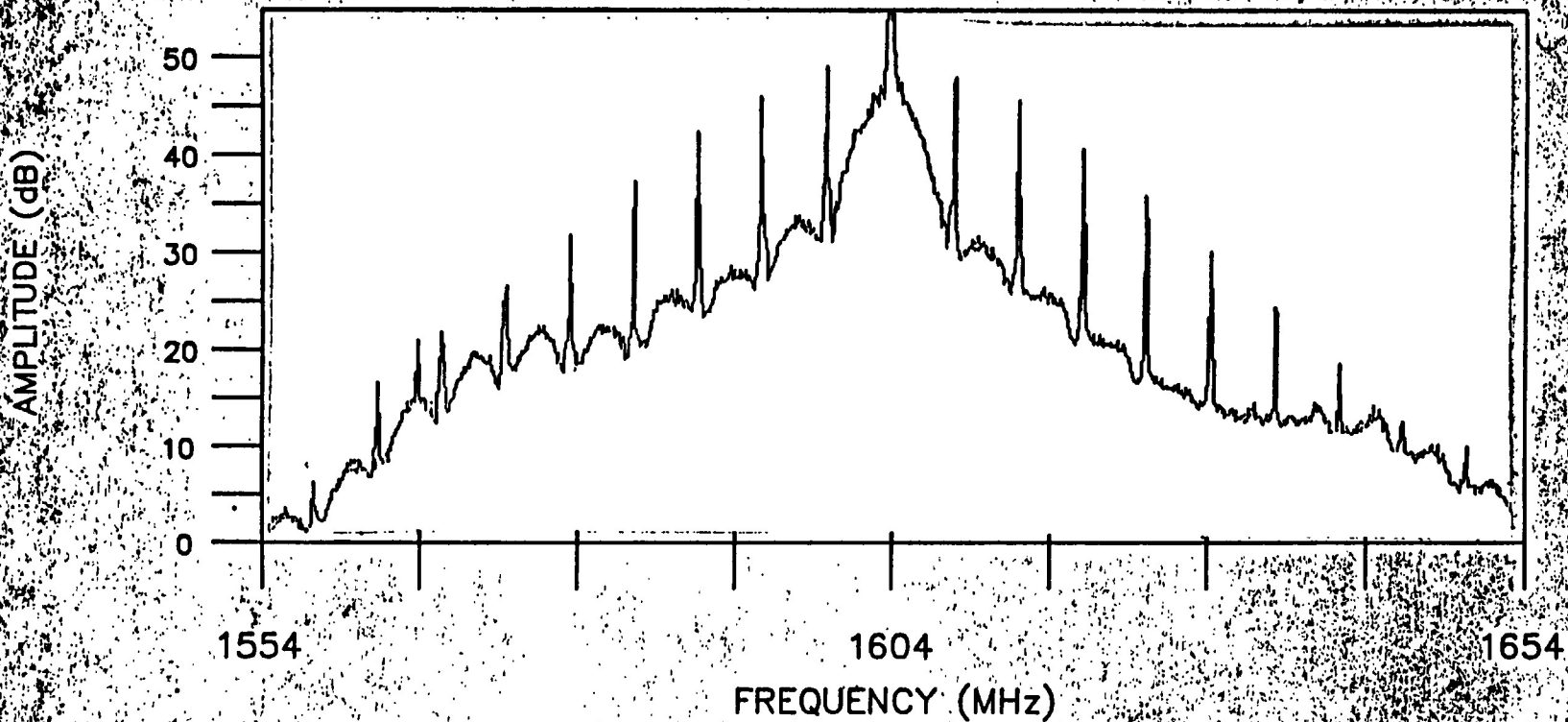


Figure 6B

COSMOS 1710

Spectrum B

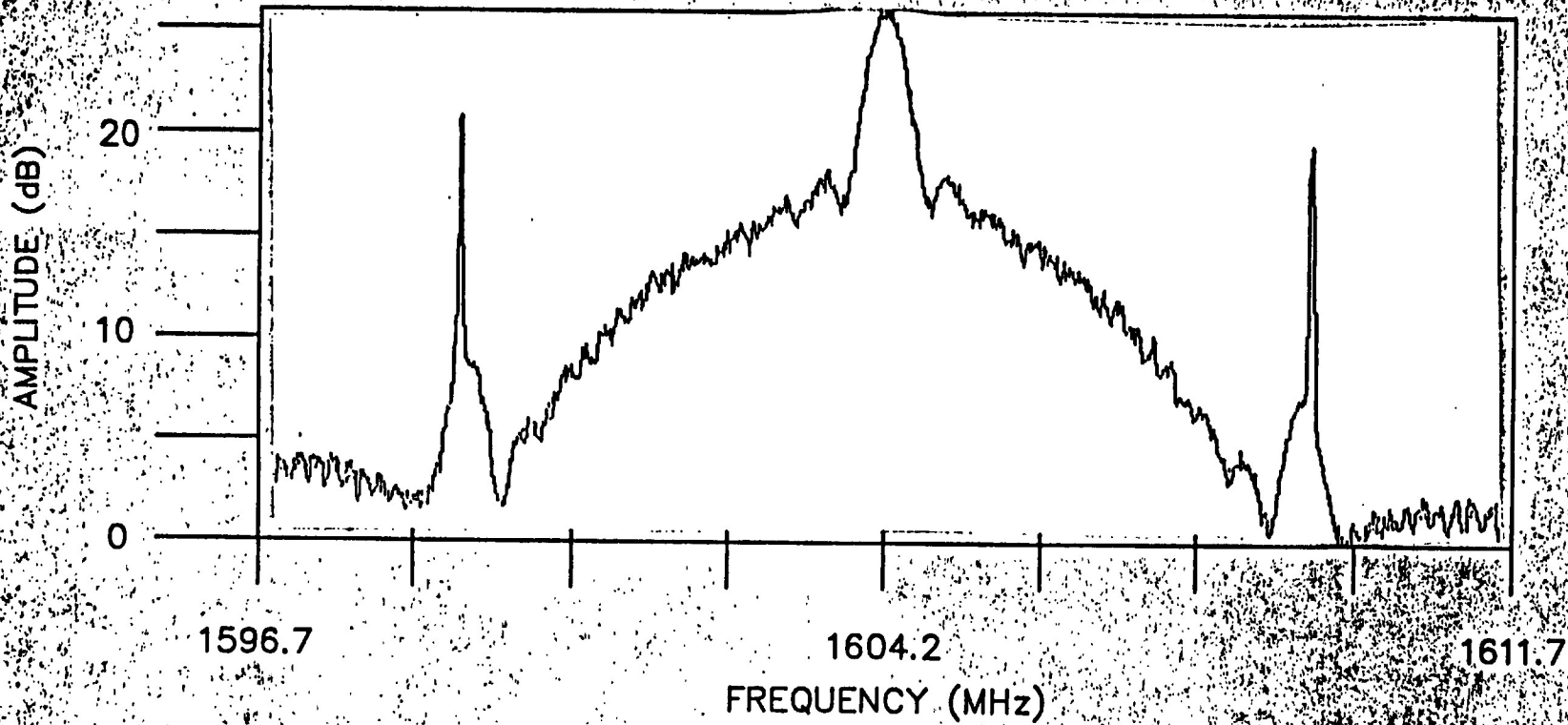
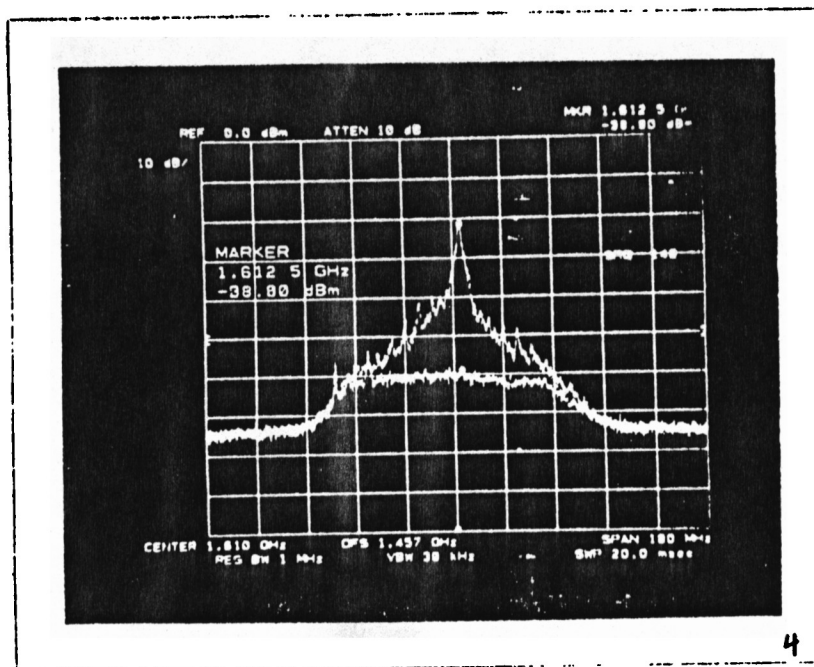


Figure 6C

COSMOS 1710

Spectrum C



Center Freq. = 1610 MHz
 Freq. Span = 180 MHz

Figure 7A

COSMOS 1711

Spectrum A

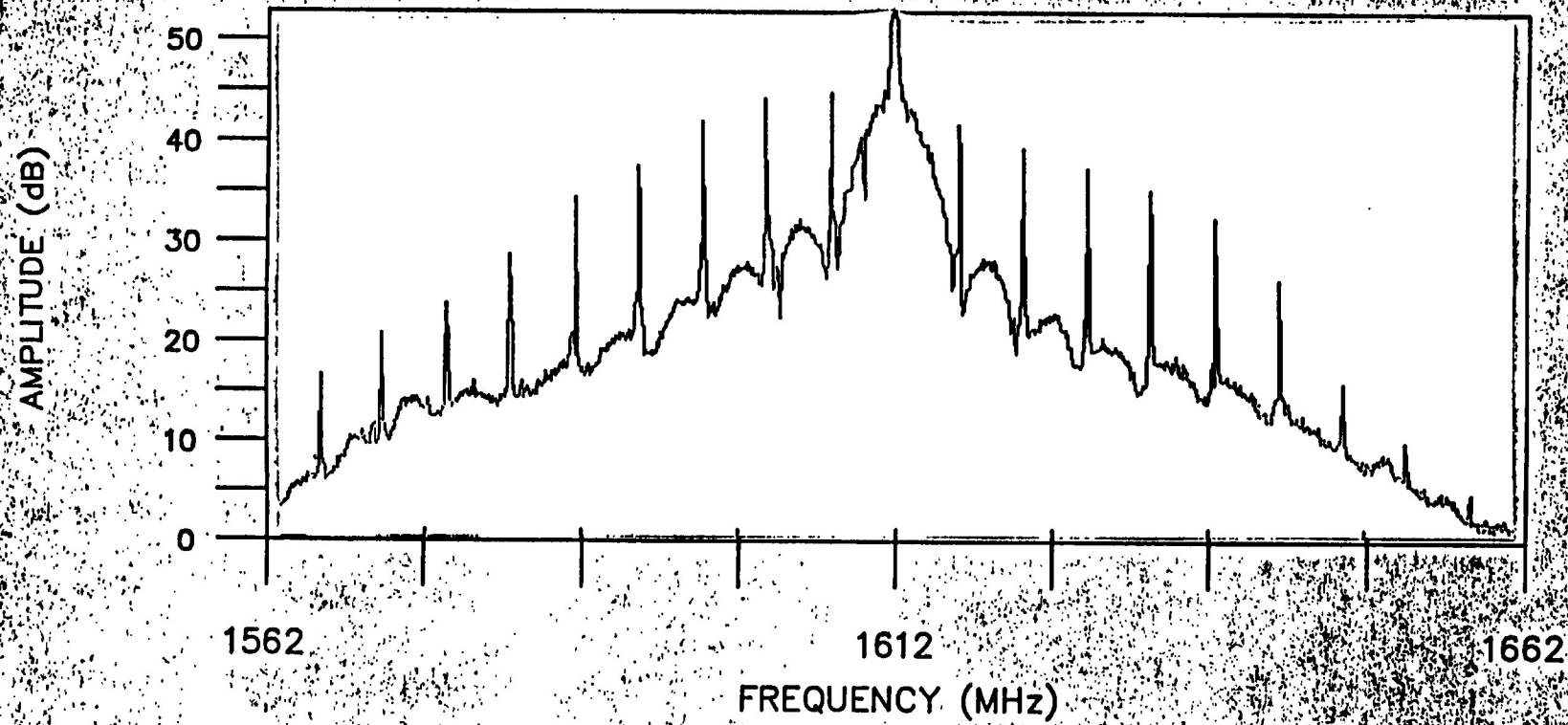


Figure 7B

COSMOS 1711

Spectrum B

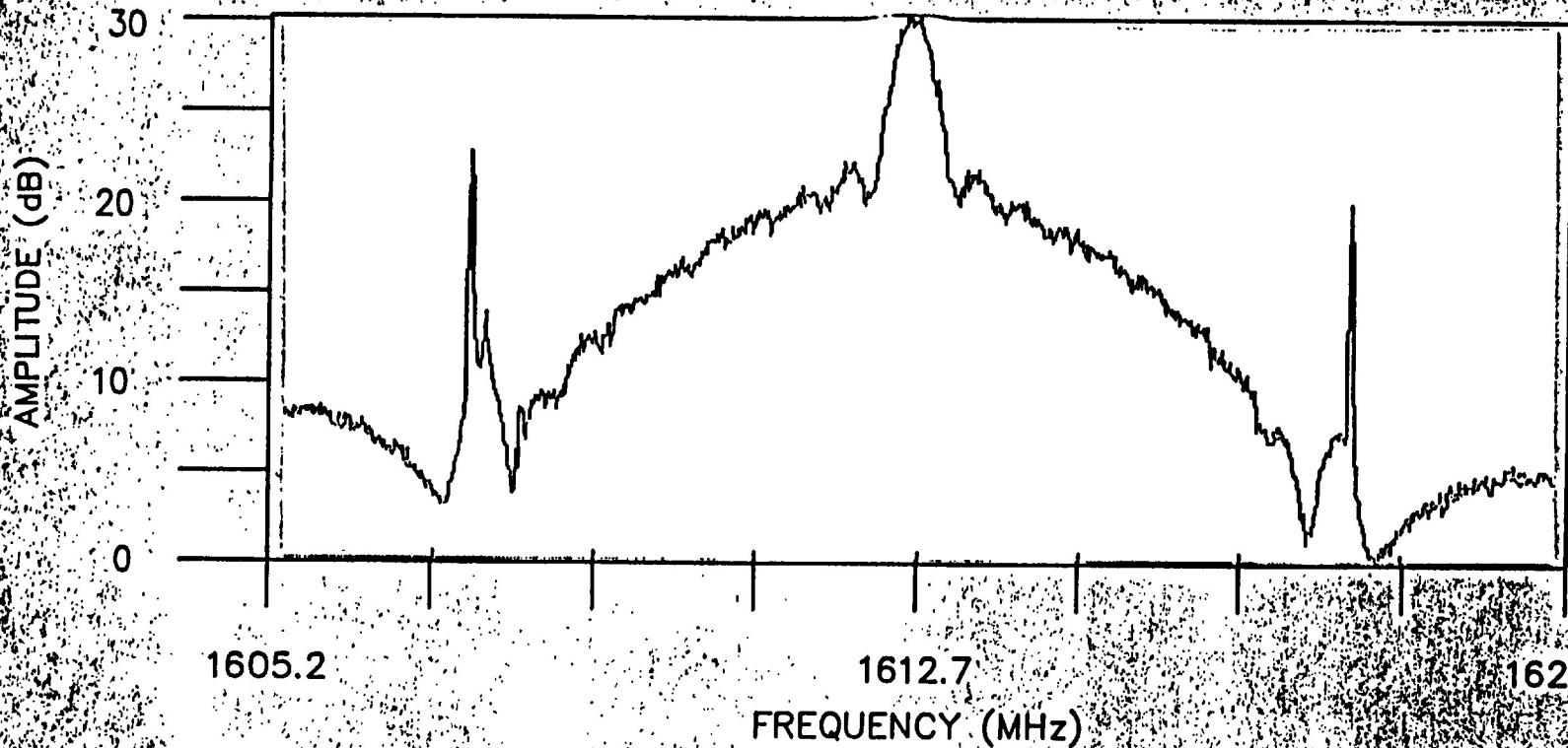
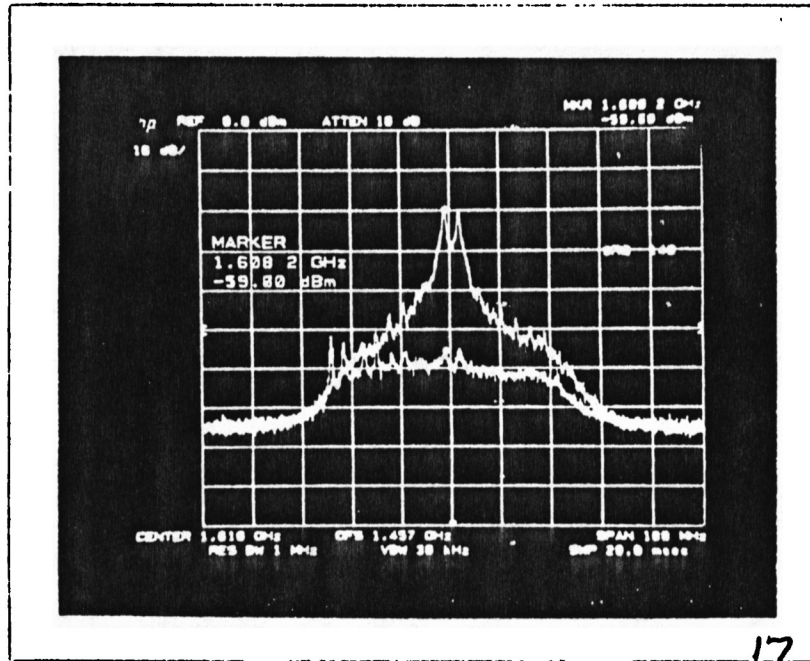


Figure 7C

COSMOS 1711

Spectrum C



Center Freq. = 1610 MHz
 Freq. Span = 180 Mhz

NOTE: Both satellites have the same sky position.
 The spectrum includes signals from both.

Figure 8A

COSMOS 1778 and 1779

Spectrum A

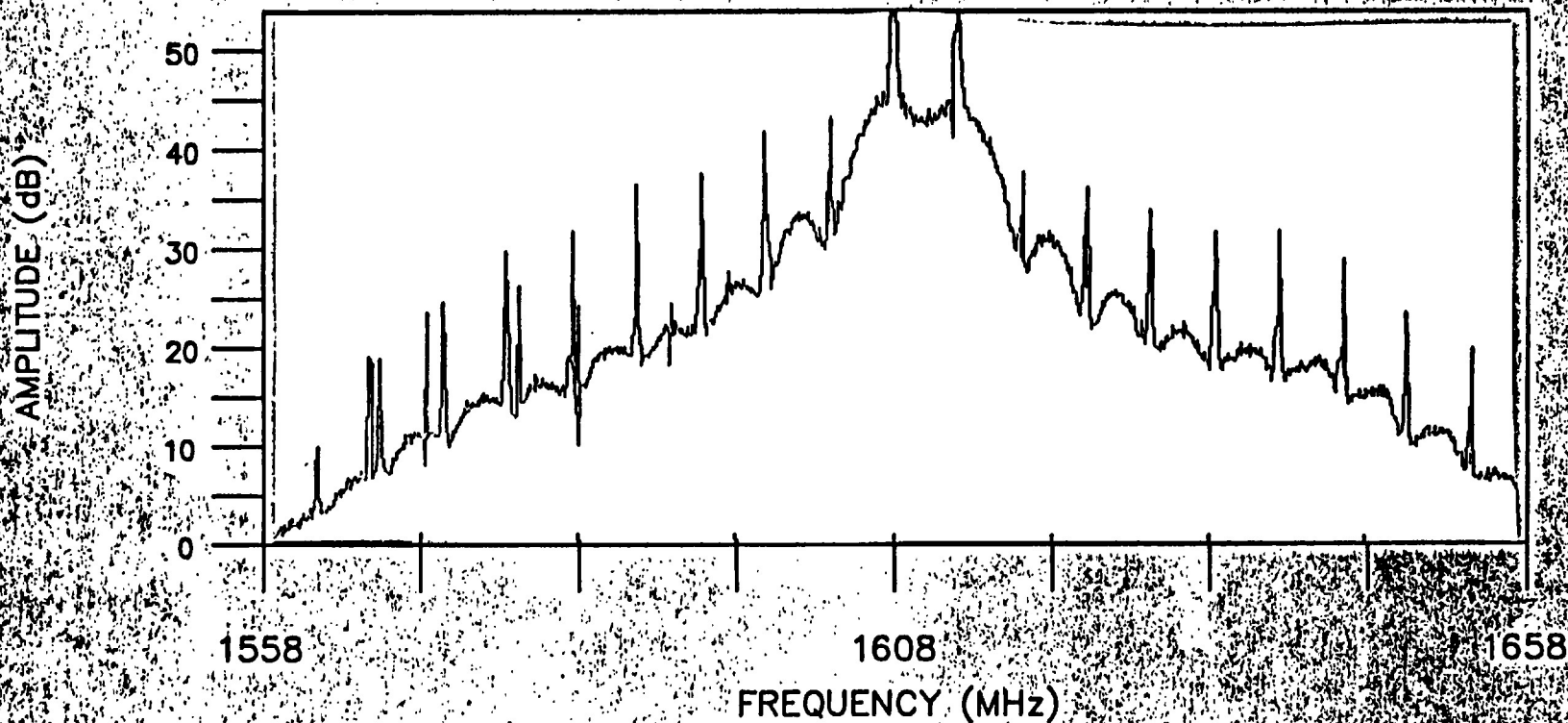


Figure 8B

COSMOS 1778 and 1779

Spectrum B

NOTE: Both satellites have the same sky position.
The spectrum includes signals from both.

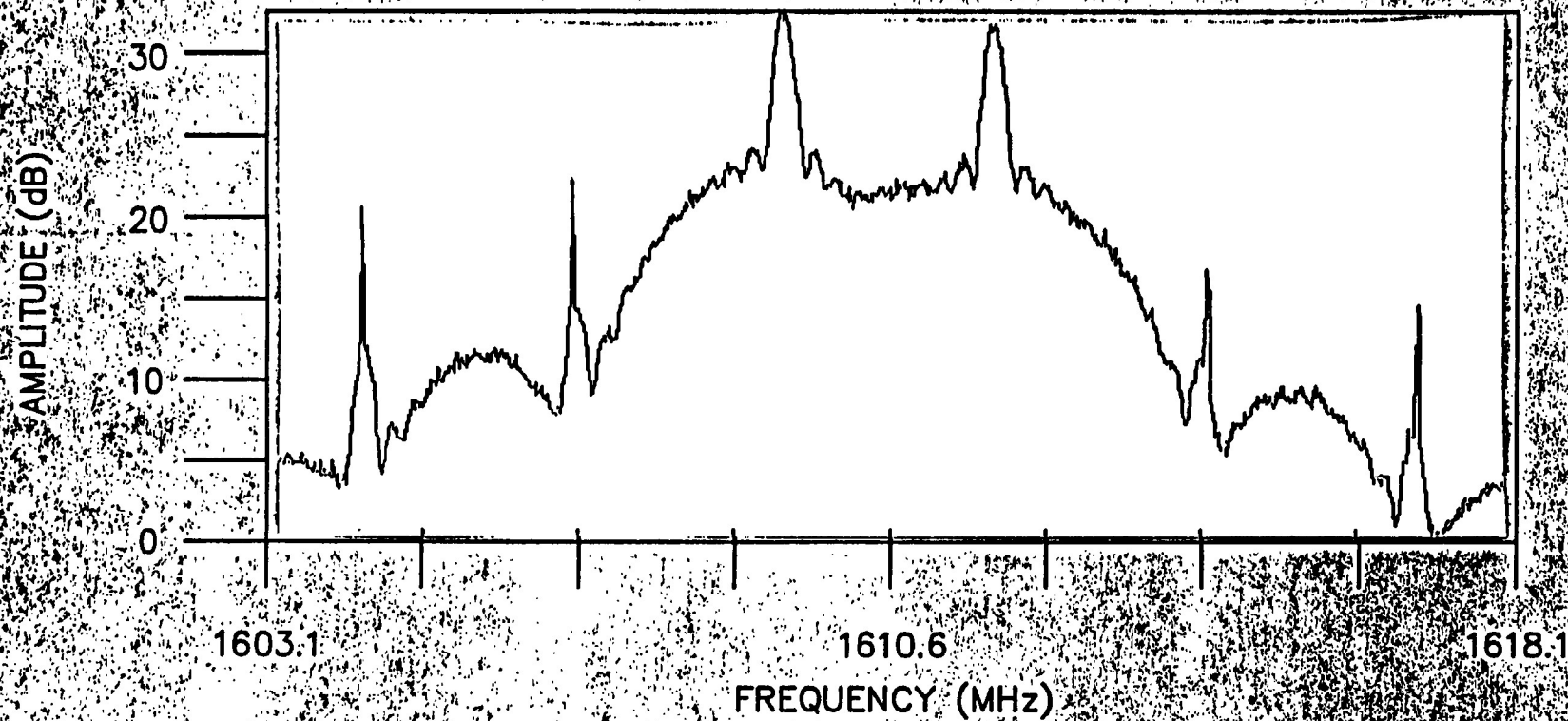
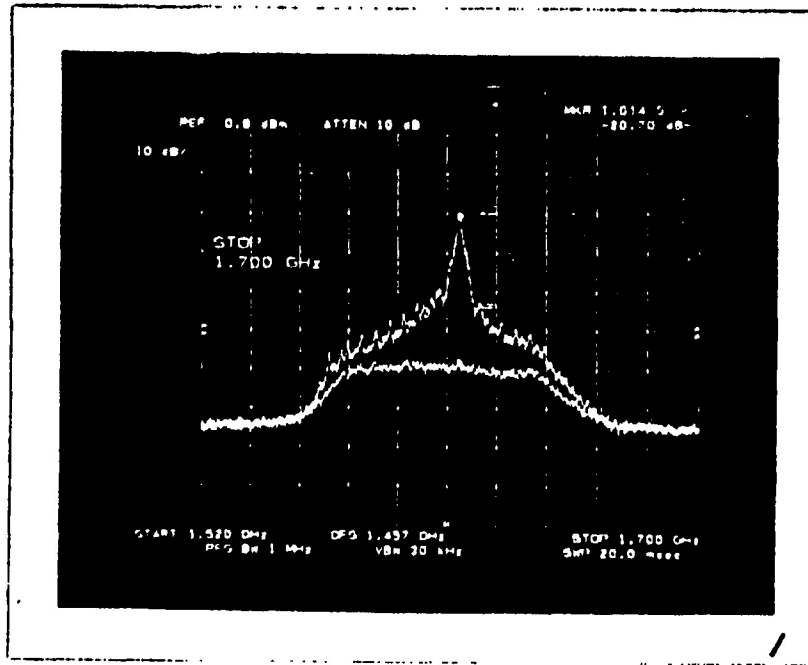


Figure 8C

NOTE: Both satellites have the same sky position.
The spectrum includes signals from both.

COSMOS 1778 and 1779
Spectrum C



Center Freq. = 1610 MHz
 Freq. Span = 180 Mhz

Figure 9A

COSMOS 1780

Spectrum A

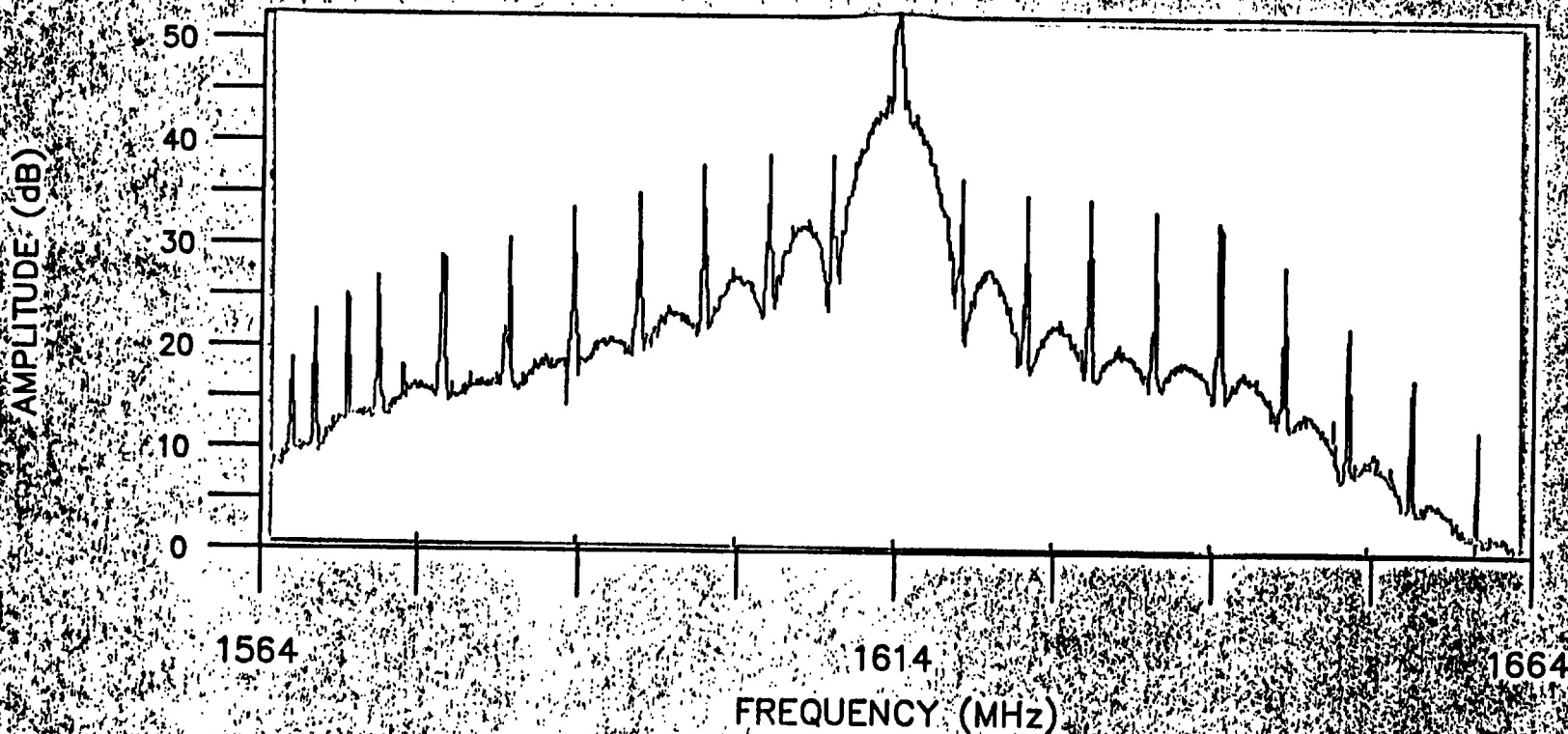


Figure 9B

COSMOS 1780

Spectrum B

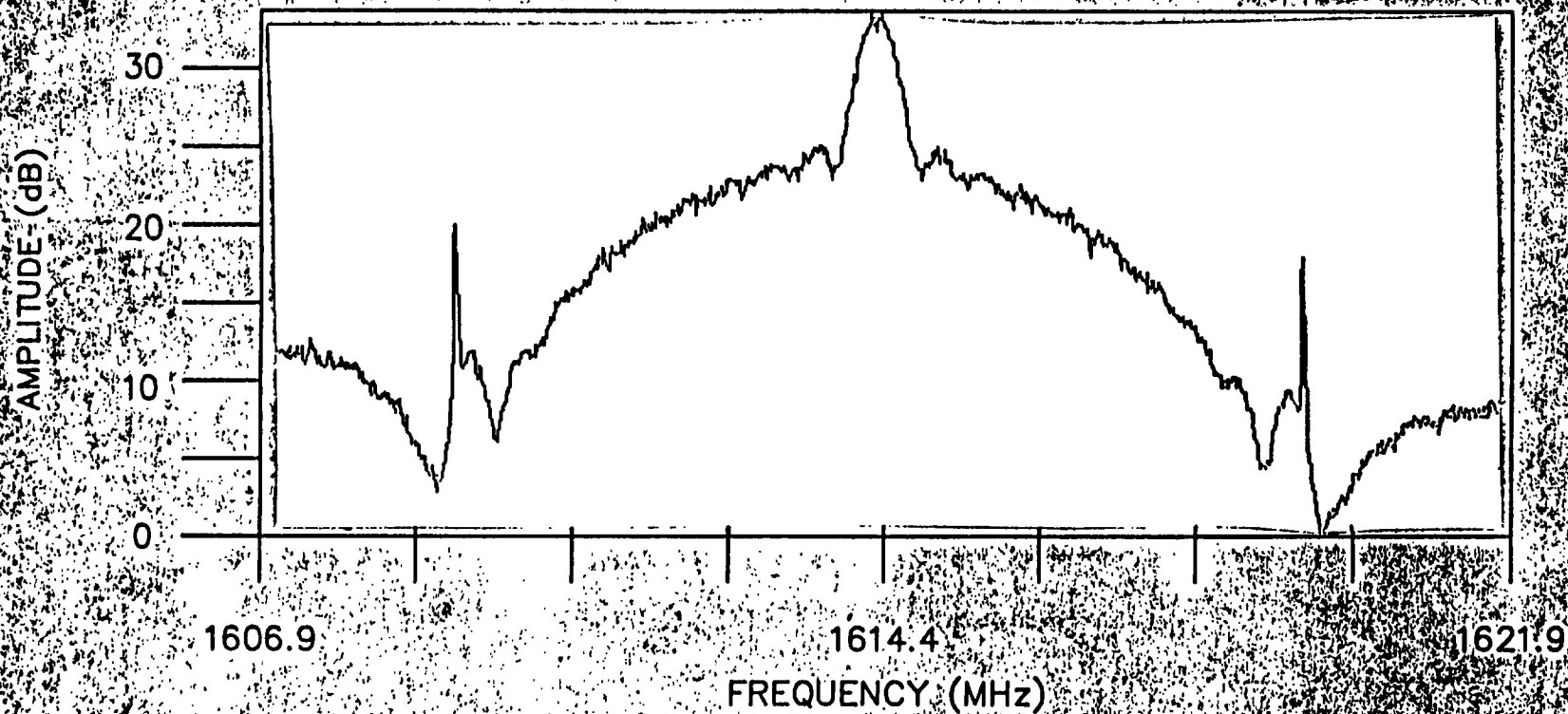


Figure 9C

COSMOS-1780

Spectrum C