Appendix D

IAU List of Important Spectral Lines in the 3mm Band

from http://www.nfra.nl/craf/iaulist.htm,

1. IAU list of important spectral lines

At the XXIst General Assembly of the International Astronomical Union, IAU, (Buenos Aires, July 23 - August 1, 1991) the astrophysically most important spectral lines have been carefully reviewed. The IAU listed the revision of these spectral lines as reproduced below. The IAU expressed the need to protect these frequency bands from in-band, band-edge and harmonic emissions, especially from space-borne transmitters.

Substance	Rest Frequency	Suggested minimum bandwidth	Notes1)
Deuterated formylium (DCO+)	72.039 GHz	71.96- 72.11 GHz	3)
Silicon monoxide (SiO)	86.243 GHz	86.16- 86.33 GHz	
Formylium (H13CO+)	86.754 GHz	86.66- 86.84 GHz	
Silicon monoxide (SiO)	86.847 GHz	86.76- 86.93 GHz	
Ethynyl radical (C2H)	87.300 GHz	87.21- 87.39 GHz	5)
Hydrogen cyanide (HCN)	88.632 GHz	88.34- 88.72 GHz	4)
Formylium (HCO+)	89.189 GHz	88.89- 89.28 GHz	4)
Hydrogen isocyanide (HNC)	90.664 GHz	90.57- 90.76 GHz	
Diazenylium (N2H)	93.174 GHz	93.07- 93.27 GHz	
Carbon monosulphide (CS)	97.981 GHz	97.65- 98.08 GHz	4)
Carbon monoxide (C18O)	109.782 GHz	109.67- 109.89 GHz	
Carbon monoxide (13CO)	110.201 GHz	109.83- 110.31 GHz	4)
Carbon monoxide (C17O)	112.359 GHz	112.25- 112.47 GHz	6)
Carbon monoxide (CO)	115.271 GHz	114.88- 115.39 GHz	4)
Formaldehyde (H213CO)	137.450 GHz	137.31- 137.59 GHz	3),6)
Formaldehyde (H2CO)	140.840 GHz	140.69- 140.98 GHz	

Carbon monosulphide (CS)	146.969 GHz	146.82- 147.12 GHz	
Water vapour (H2O)	183.310 GHz	183.12- 183.50 GHz	
Carbon monoxide (C18O)	219.560 GHz	219.34- 219.78 GHz	
Carbon monoxide (13CO)	220.399 GHz	219.67- 220.62 GHz	4)
Carbon monoxide (CO)	230.538 GHz	229.77- 230.77 GHz	4)
Carbon monosulphide (CS)	244.953 GHz	244.72- 245.20 GHz	6)
Hydrogen cyanide (HCN)	265.886 GHz	265.62- 266.15 GHz	
Formylium (HCO+)	267.557 GHz	267.29- 267.83 GHz	
Hydrogen isocyanide (HNC)	271.981 GHz	271.71- 272.25 GHz	
Dyazenulium (N2H+)	279.511 GHz	279.23- 279.79 GHz	
Carbon monoxide (C18O)	312.330 GHz	329.00- 329.66 GHz	
Carbon monoxide (13CO)	330.587 GHz	330.25- 330.92 GHz	
Carbon monosulphide (CS)	342.883 GHz	342.54- 343.23 GHz	
Carbon monoxide (CO)	345.796 GHz	345.45- 346.14 GHz	
Hydrogen cyanide (HCN)	354.484 GHz	354.13- 354.84 GHz	
Formylium (HCO+)	356.734 GHz	356.37- 357.09 GHz	
Dyazenulium (N2H+)	372.672 GHz	372.30- 373.05 GHz	
Water vapour (H2O)	380.197 GHz	379.81- 380.58 GHz	
Carbon monoxide (C18O)	439.088 GHz	438.64- 439.53 GHz	
Carbon monoxide (13CO)	440.765 GHz	440.32- 441.21 GHz	
Carbon monoxide (CO)	461.041 GHz	460.57- 461.51 GHz	
Heavy water (HDO)	464.925 GHz	464.46- 465.39 GHz	
Carbon (CI)	492.162 GHz	491.66- 492.66 GHz	
Water vapour (H218O)	547.676 GHz	547.13- 548.22 GHz	
Water vapour (H2O)	556.936 GHz	556.37- 557.50 GHz	
Ammonia (15NH3)	572.113 GHz	571.54- 572.69 GHz	
Ammonia (NH3)	572.498 GHz	571.92- 573.07 GHz	
Carbon monoxide (CO)	691.473 GHz	690.78- 692.17 GHz	
Hydrogen cyanide (HCN)	797.433 GHz	796.64- 789.23 GHz	
Formylium (HCO+)	802.653 GHz	801.85- 803.85 GHz	
Carbon monoxide (CO)	806.652 GHz	805.85- 807.46 GHz	
Carbon (CI)	809.350 GHz	808.54- 810.16 GHz	

1): If Note 4) or Note 2) are not listed, the band limits are Doppler-shifted frequencies corresponding to radial velocities of +/- 300 km/s (consistent with line radiation occurring in our galaxy).

2): An extension to lower frequencies of the allocation of 1400-1427 MHz is required to allow for the Doppler shifts for HI observed in distant galaxies.

3): The current international allocation is not primary and/or does not meet bandwidth requirements. See: ITU-R Radio Regulations (Table 8) for more detailed information.

4): Because these line frequencies are also being used for observing other galaxies, the listed bandwidths include Doppler shifts corresponding to radial velocities of up to 1000 km/s. It should be noted that HI has been observed at frequencies redshifted to 500 MHz, while some lines of the most abundant molecules have been detected in galaxies with velocities up to 50 000 km/s, corresponding to a frequency reduction of up to 17%.

5): There are six closely spaced lines associated with this molecule at this frequency. The listed band is wide enough to permit observations of all six lines.

6): This line is not mentioned in Article 8 of the ITU-R Radio Regulations.

2. Supplementary list of important spectral lines of the IUCAF mm-wave working group

In preparation of the World Radiocommunication Conference 2000, WRC-2000, which revised the allocations above 71
GHz, the IUCAF mm-wavelength working group has examined all known transitions in the millimeter and submillimeter
wavebands. They have selected a limited number of the astrophysically most important spectral lines. This list supplements
earlier lists such as those produced by the International Astronomical Union, IAU, (see above) and is to be used in allocating
frequency bands to the Radio Astronomy Service.

Oxygen (O2)	62.486 GHz	62.42 - 62.55 GHz
Deuterated formylium (DCO+)	72.039 GHz	71.97 - 72.11 GHz
Deuterium cyanide (DCN)	72.415 GHz	72.34 - 72.49 GHz
Cyanoacetylene (HC3N)	72.784 GHz	72.71 - 72.86 GHz
Methyl cyanide (CH3CN)	73.59 GHz	73.51 - 73.66 GHz
Deuterated water (HDO)	80.578 GHz	80.50 - 80.66 GHz
Cyanoacetylene (HC3N)	81.881 GHz	81.80 - 81.96 GHz
Cyclopropenylidene (C3H2)	82.966 GHz	82.88 - 83.05 GHz
Cyclopropenylidene (C3H2)	85.339 GHz	85.05 - 85.42 GHz
Methyl acetylene (CH3CCH)	85.5 GHz	85.41 - 85.59 GHz

Deuterated Ammonia (NH2D)	85.926 GHz	85.84 - 86.01 GHz
Hydrogen cyanide (HC15N)	86.055 GHz	85.97 - 86.14 GHz
Silicon monoxide (SiO)	86.243 GHz	86.16 - 86.33 GHz
Hydrogen cyanide (H13CN)	86.340 GHz	86.25 - 86.43 GHz
Formylium (H13CO+)	86.754 GHz	86.67 - 86.84 GHz
Hydrogen isocyanide (HN13C)	87.091 GHz	87.00 - 87.18 GHz
Silicon monoxide (SiO)	86.847 GHz	86.76 - 86.93 GHz
Ethynyl radical (C2H)	87.300 GHz	87.21 - 87.39 GHz
Hydrogen cyanide (HCN)	88.632 GHz	88.34 - 88.72 GHz
Hydrogen isocyanide (H15NC)	88.866 GHz	88.78 - 88.95 GHz
Formylium (HCO+)	89.189 GHz	88.89 - 89.28 GHz
Hydrogen isocyanide (HNC)	90.664 GHz	90.57 - 90.75 GHz
Cyanoacetylene (HC3N)	90.979 GHz	90.89 - 91.07 GHz
Methyl cyanide (CH3CN)	91.98 GHz	91.88 - 92.07 GHz
Carbon monosulphide (13CS)	92.494 GHz	92.40 - 92.59 GHz
Diazenylium (N2H+)	93.174 GHz	93.08 - 93.27 GHz
Carbon monosulphide (C34S)	96.413 GHz	96.32 - 96.51 GHz
Carbon monosulphide (CS)	97.981 GHz	97.65 - 98.08 GHz
Sulphur monoxide (SO)	99.300 GHz	99.20 - 99.40 GHz
Cyanoacetylene (HC3N)	100.076 GHz	99.98 - 100.18 GHz
Methyl acetylene (CH3CCH)	102.5 GHz	102.39 - 102.60 GHz
Cyanoacetylene (HC3N)	109.174 GHz	109.06 - 109.28 GHz
Sulphur monoxide (SO)	109.252 GHz	109.14 - 109.36 GHz
Carbon monoxide (C18O)	109.782 GHz	109.67 - 109.89 GHz
Deuterated Ammonia (NH2D)	110.153 GHz	110.04 - 110.26 GHz
Carbon monoxide (13CO)	110.201 GHz	119.83 - 110.31 GHz
Methyl cyanide (CH3CN)	110.38 GHz	110.27 - 110.49 GHz
Carbon monoxide (C17O)	112.359 GHz	112.25 - 112.47 GHz
Cyano radical (CN)	113.500 GHz	113.39 - 113.61 GHz
Carbon monoxide (CO)	115.271 GHz	114.88 - 115.39 GHz