Frequencies reserved to the radio astronomy

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During the XXI General Assembly of the IAU (International Astronomical Union), which took place in Buenos Aires in 1991, was compiled a detailed list of the most important frequencies associated with the spectral lines of fundamental astrophysical interest. The IAU has clearly expressed the need to reserve for the scientific use of these frequency bands and to guarantee absolute protection from artificial broadcasting both within themselves and as close to the boundaries of the band, as well as emissions from whose harmonics fall significantly within the protected spectral regions, especially compared to radio from transmitters deployed on artificial satellites board. Technical support is also guaranteed by CRAF (Committee on Radio Astronomy Frequencies), which is a body of the ESF (European Science Foundation) responsible for monitoring compliance with the agreements related to the use of the reserved frequencies allocated to radio astronomy research.

The list of frequencies reserved is the follow (http://www.nfra.nl/craf/iaulist.htm):

Substance	**Center frequency**	**Suggested minimum bandwidth (1)**
Deuterium (DI):	327.384 MHz	327.0 - 327.7 MHz
Hydrogen (HI)	1420.406 MHz	1370.0 – 1427.0 MHz (2), (3)
Hydroxyl radical (OH)	1612.231 MHz	1606.8 – 1613.8 MHz (3), (4)
Hydroxyl radical (OH)	1665.402 MHz	1659.8 – 1667.1 MHz (4)
Hydroxyl radical (OH)	1667.359 MHz	1661.8 – 1669.0 MHz (4)
Hydroxyl radical (OH)	1720.530 MHz	1714.8 – 1722.2 MHz (3), (4)
Methyladyne (CH)	3263.794 MHz	3252.9 – 3267.1 MHz (3), (4)
Methyladyne (CH)	3335.481 MHz	3324.4 – 3338.8 MHz (3), (4)
Methyladyne (CH)	3349.193 MHz	3338.0 – 3352.5 MHz (3), (4)
Formaldehyde (H_2CO)	4829.660 MHz	4813.6 – 4834.5 MHz (3), (4)
Methanol (CH_2OH)	6668.518 MHz	6661.8 – 6675.2 MHz (3), (6)
Ionized Helium Isotope (^{3}HeII)	8665.650 MHz	8660.0 – 8670.0 MHz
Methanol (CH_3OH)	12.178 GHz	12.17 – 12.19 GHz (3), (6)
Formaldehyde (H_2CO)	14.488 GHz	14.44 – 14.50 GHz (3), (4)
Cyclopropenylidene (C_3H_2)	18.343 GHz	18.28 – 18.36 GHz (3), (4), (6)
Water Vapour (H_2O)	22.235 GHz	22.16 – 22.26 GHz (3), (4)
Ammonia (NH_3)	23.694 GHz	23.61 – 23.71 GHz (4)
Ammonia (NH_3)	23.723 GHz	23.64 – 23.74 GHz (4)
Ammonia (NH_3)	23.870 GHz	23.79 – 23.89 GHz (4)
Silicon monoxide (SiO)	42.821 GHz	42.77 – 42.86 GHz
Silicon monoxide (SiO)	43.122 GHz	43.07 – 43.17 GHz
Carbon monosulphide (CS)	48.991 GHz	48.94 – 49.04 GHz
Deuterated formylium (DCO^+)	72.039 GHz	71.96 – 72.11 GHz (3)
Silicon monoxide (SiO)	86.243 GHz	86.16 – 86.33 GHz

Formylium ($H^{13}CO^+$)	86.754 GHz	86.66 – 86.84 GHz
Silicon monoxide (SiO)	86.847 GHz	86.76 – 86.93 GHz
Ethynyl radical (C_2H)	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	89.89 – 89.28 GHz (4)
Hydrogen isocyanide (HNC)	90.664 GHz	90.57 – 90.76 GHz
Diazenylium (N_2H)	93.174 GHz	93.07 – 93.27 GHz
Carbon monosulphide (CS)	97.981 GHz	97.65 – 98.08 GHz (4)
Carbon monoxide ($C^{18}O$)	109.782 GHz	109.67 – 109.89 GHz
Carbon monoxide (^{13}CO)	110.201 GHz	109.83 – 110.31 GHz (4)
Carbon monoxide ($C^{17}O$)	112.359 GHz	112.25 – 112.47 GHz (6)
Carbon monoxide (CO)	115.271 GHz	114.88 – 115.39 GHz (4)
Formaldehyde ($H_2{}^{13}CO$)	137.450 GHz	137.31 – 137.59 GHz (3), (6)
Formaldehyde (H_2CO)	140.840 GHz	140.69 – 140.98 GHz
Carbon monosulphide (CS)	146.969 GHz	146.82 – 147.12 GHz
Water Vapour (H_2O)	183.310 GHz	183.12 – 183.50 GHz
Carbon monoxide ($C^{18}O$)	219.560 GHz	219.34 – 219.78 GHz
Carbon monoxide (^{13}CO)	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 (N_2H^+)	279.511 GHz	279.23 – 279.79 GHz
Carbon monoxide ($C^{18}O$)	312.330 GHz	329.00 – 329.66 GHz
Carbon monoxide (^{13}CO)	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
Diazenylium (N_2H^+)	372.672 GHz	372.30 – 373.05 GHz
Water Vapour (H_2O)	380.197 GHz	379.81 – 380.58 GHz
Carbon monoxide ($C^{18}O$)	439.088 GHz	438.64 – 439.53 GHz
Carbon monoxide (^{13}CO)	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 ($H_2{}^{18}O$)	547.676 GHz	547.13 – 548.22 GHz
Water Vapour (H_2O)	556.936 GHz	556.37 – 557.50 GHz
Ammonia ($^{15}NH_3$)	572.113 GHz	571.54 – 572.69 GHz
Ammonia (NH_3)	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

Notes:

(1) In the absence of further information, the minimum width of the bands of frequency is related to the values of the frequency shifts due to Doppler effect, corresponding to the radial velocity of + / -300 km / s (consistent with the emission line that occurs in our galaxy).

(2) extension is required at lower frequencies, compared to the traditional allocation 1400-1700 MHz, to allow proper observation of the Doppler shifts relative to the HI clouds in far galaxies.

(3) The current international allocation does not specify requirements for bandwidth. For more details, see ITU-R Radio Regulations (Table 8).

(4) Since these spectral lines are also used for the observation of other galaxies (besides ours), the bandwidths include Doppler shifts corresponding to radial velocities up to 1000 km / s. It is worth noting how the HI clouds have been observed at frequencies up to 500 MHz with redshift, while some spectral lines of the most abundant molecules have been detected in galaxies with speeds up to 50000 km / s, corresponding to a reduction in the frequency range up to 17%.

(5) There has been 6 very close spectral lines associated with this molecule, the specified frequency. The band shown is sufficiently broad to allow observation of all rows.

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

With the growing and massive occupation of the radio spectrum, operating within the frequency bands reserved, the radio astronomy observations are made difficult due to the enormous amount of interfering signals in space. These problems are further compounded by the high sensitivity and the wide bandwidth of the receivers. The artificial disturbances propagate along the surface of the ground (for ground wave) and above the horizon (for direct wave): the propagation interference to ground wave undergoes considerable attenuation, to the point of significantly weaken at ground level, while the propagated noise for direct wave tend to increase due to the combination of all the contributions due to several different sources. They are therefore favored low-profile antenna systems, being less susceptible to terrestrial interference. Additional sources of interference are transmitters and transponders located on board of artificial satellites for telecommunications, constantly and rapidly increasing.
The current situation is problematic: research institutes are assisting, most of the time powerless, in a progressive and constant possession of frequencies reserved, operated primarily by the bridges transfer fees for commercial radio and television broadcasters (with considerable power), the incessant occupation of space by artificial satellites and the enormous development of mobile cellular networks (terrestrial and satellite radio). In a similar scenario, assume primary importance the choice of the installation site for radio astronomy systems, choice to be made favoring locations possibly shielded from natural relief so as to minimize the possibility of interference with the terrestrial radio service, however not without having conducted an accurate measurement campaign (using scanner receivers and spectrum analyzers) to determine the level of "electromagnetic pollution" locally present in the frequency band of interest.

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