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TITLE: HIFI most wanted frequencies

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I. Introduction

I.1 Purpose

This document compiles the lines identified as most requested among the various topical core programs. It is meant at helping the test engineers and calibrators to decide at which frequencies the limited amount of test time available should be preferrably dedicated. A priority rank is attributed to each line, based mostly on scientific return. Most wanted lines and selection criteria are described for each of the core program topical teams.

I.2 References

I.2.1 Applicable documents

I.2.2 Reference documents

RD-01 HIFI Science Core Program, *http://www.sron.rug.nl/hifiscience/CoreProgramme/*

II. Most wanted lines

II.1 Selection criteria

This section compiles the selection criteria applied by each of the topical teams to build the lists presented in II.2.

II.1.a Galaxies and galactic nuclei

The tables contain a limited amount of lines corresponding to Appendix A of the core program document related to the galaxies and galactic nuclei topics (RD-01). They are considered with the same priority level and are thus all assigned the highest priority.

II.1.b Solar system bodies

The table includes the preferred lines for both planetary and cometary core programs. The justifications for the line choices can be found in the corresponding chapters of the core program description (RD-01). In the particular case of the comets, priority 3 samples H_2O and HDO lines in the most sensitive frequency range of HIFI. Priority 2 contains other H_2O and HDO (as well as isotopomers) required to study the excitation and o/p ratio. Priority 1 contains other lines of interest for the considered objects, as well as lines obtain at no extra cost in the image band.

II.1.c Insterstellar medium

Priorities are assigned on the bias of scientific merit (3: high, 2: medium, 1: low).

II.1.d Star formation

Most of the reported lines have priority 3 (highest priority), as listed in the appendixes of the Star Formation Program v.3 (2nd June), available at RD-01. A few lines are ranked priority 1 and are at low priority. The selection criteria are described in detail the proposal for each molecule or water line, for each subsection of the proposal. The general criteria are that the observations of the selected lines are not feasable, or with a lot of difficulty, with the present or future telescopes (including APEX and SOFIA).

II.1.e Stellar evolution

The priorities we asign to lines are mainly the same as the priorities we give in our proposal to the subprojects in which those lines are requested. Namely:

- Water lines:
  - Priority 1 is given to lines included in two subprojects see Part I, Sects. 3.1 (observations of 55 lines in 4 selected sources) and 3.3 (observations of 20 lines in 20 sources). The first of these subprojects has our highest priority among water observations.
  - Priority 2 is given to lines to be observed only in the first project (Sect. 3.1).

- Other lines
  - Priority 1 is given to lines included in our systematic observations of AGB, PPNe and PNe (Sect. 4, Part I), which has the highest priority among our subprojects. Most of these lines are also included in the systematic molecular observations of hot, massive stars (Sects. 5.4.2 and 5.4.4 Part II).
  - Priority 2: a few lines in Sects. 5.4.2 and 5.4.4 Part II that are not to be observed in evolved star envelopes, plus lines of hydrides in AGBs, PPNe and PNe (a second priority project).
  - Priority 3 is given to lines in our search of C[I] and C[II] emission (our 3rd priority project), except for lines included in Sects. 5.4.2 and 5.4.4 (Part II), which have 2nd priority.

II.2 Most wanted frequency tables

In the following, we list the most wanted lines for each of the HIFI bands. Note that some frequencies are uncertain.

HIFI Band 1

Species	Frequency (GHz)	Priorities				
		Galaxies	Solar System bodies	ISM	Star formation	Stellar evolution
O_2	487.2				3	
CS	489.751					1
C	492.161	3		2	3	2
NH_2D	494.454			1		
NH_2D	494.455			1		
NH_2D	494.457			1		
HDO	509.329		3 (comet)			
SiO	520.878					1
H_2O	530.343					
CH	532.721			2		2
CH	536.761		1 (comet)	2	3	2
H_2O-*para*	546.621					1
$H_2{}^{18}O$-*ortho*	547.676	3	2 (comet)	3	3	
$C^{18}O$	548.831					
^{13}CO	550.926					
$H_2{}^{17}O$-*ortho*	552.021		2 (comet)		3	
H_2O-*ortho*	556.936	3	1(planet)/3(comet)	3	3	1
CN	566.942					1
$^{15}NH_3$	572.113			1		2
NH_3-*ortho*	572.498		1 (comet)	2	3	
CO	576.268					
HDO	599.927		2 (comet)			
D_2O	607.350			1	3	
HCN	620.304					1
H_2O-*ortho*	620.701					2
HCO^+	624.205					1
$H^{37}Cl$	624.964			1		
$H^{37}Cl$	624.978			1		
$H^{37}Cl$	624.988			1		
$H^{35}Cl$	625.901			1	3	
$H^{35}Cl$	625.919			1		
$H^{35}Cl$	625.932			1		

HIFI Band 2

Species	Frequency (GHz)	Priorities				
		Galaxies	Solar System Bodies	ISM	Star formation	Stellar evolution
H_2O-*para*	645.834					2
H_2O-*ortho*	651.099					2
SiH	658.009				3	
DF	660.000			1		
^{13}CO	661.067					1
CO	691.473					1
O_2	715.4				3	
H_2S-*ortho*	736.034		1 (comet)	1	1	
$H_2{}^{18}O$-*ortho*	745.320				3	
H_2O-*para*	750.501					2
H_2O-*ortho*	750.572					2
H_2O-*para*	752.033		2 (planet & comet)	3	3	2
H_2O-*para*	766.860					2
^{13}CO	771.184					
O_2	773.8				3	

HIFI Band 3

Species	Frequency (GHz)	Priorities				
		Galaxies	Solar System Bodies	ISM	Star formation	Stellar evolution
CO	806.652					
^{13}C	809.1				3	
C	809.342	3		2	3	3
CH^+	835.071		1 (comet)	3	3	2
H_2CO	855.151				1	
H_2O-*para*	859.859					2
H_2O-*ortho*	863.855					2
H_2O-*para*	863.876					2
^{13}CO	881.273					2
$HD^{18}O$	883.189			1		
LiH	887.0				3	
HDO	893.639		3 (comet)	3	3	
H_2CO-*o*	896.7				1	
H_2CO	896.805					
D_2O	896.947			1		
H_2O-*para*	899.410					2
H_2O-*ortho*	902.564					2
H_2O	906.206					
H_2O-*para*	916.171				3	2
CO	921.800					2
CS	929.723					1
CH_2	930.		1 (comet)			
NH_2	952.542			1		
NH_2	959.526			1		

HIFI Band 4

Species	Frequency (GHz)	Priorities				
		Galaxies	Solar System Bodies	ISM	Star formation	Stellar evolution
H_2O-*para*	970.315				3	
OH^+	971.804		1 (comet)	3		
NH	974.462		1 (comet)	3	3	
OH^+	984.532					1
H_3O^+	984.6				3	
H_3O^+	984.697		1 (comet)	3		
$C^{18}O$	987.6		3			
H_2O-*para*	987.927	3	2 (planet & comet)	3	3	2
^{13}CO	991.329		2			
$H_2{}^{18}O$-*para*	994.675	3			3	
NH	999.973			3		
H_2O-*ortho*	1000.092					2
H_2S	1002.779				1	
$C^{17}O$	1010.7		3			
NH^+	1012.524			2		
CO	1036.912		2	2		
NH^+	1038.1				3	
H_2O_2	1047.377		1			
HCN	1062.983					1
HCO^+	1069.697					1
H_2S	1072.8		3			
$C^{18}O$	1097.163				3	
H_2O-*ortho*	1097.364		2	2	3	1
H_2O-*para*	1100.088					1
$C^{13}O$	1101.350			3	3	1
$H_2{}^{18}O$-*para*	1101.698	3		3	3	
$H_2{}^{17}O$-*para*	1107.167				3	
H_2O-*para*	1109.586					1
H_2D^+	1111.741				3	
H_2O-*para*	1113.343	3	2 (planet & comet)	3	3	1

HIFI Band 5

Species	Frequency (GHz)	Priorities				
		Galaxies	Solar System Bodies	ISM	Star formation	Stellar evolution
O_2	1120.715		1			
CN	1133.199					1
$H_2{}^{18}O$	1136.7		2			
$H_2{}^{17}O$	1149.0		2			
CO	1151.985	3		2	3	1
NO	1152.9		3			
H_2O-*ortho*	1153.118				3	2
H_2O-*ortho*	1153.359					2
H_2O-*para*	1155.095					2
H_2O-*ortho*	1155.098					2
H_2O-*ortho*	1158.324				3	
H_2O-*ortho*	1162.931		1	2	3	2
H_2O-*ortho*	1165.0				3	
NH_3	1168.517			2		2
SiO	1170.094					1
H_2O-*para*	1172.448					2
CO^+	1178.766				3	
CO^+	1179.039					
O_3	1180.3		1			
$H_2{}^{18}O$-*ortho*	1181.394				3	
H_2CO	1185.0		1			
H_2O-*ortho*	1196.859					1
H_2O-*para*	1205.825					1
H_2O-*para*	1207.666					1
^{13}CO	1211.330					
H_2O-*ortho*	1214.615					1
NH_3	1214.859					2
NH_3	1215.245				1	2
H_2O-*ortho*	1215.830					1
H_2O-*para*	1215.961					1
HDO	1217.3		1			
H_2O-*para*	1228.799			2	3	1
HF	1232.476			1	3	
HCl	1251.4		3			

HIFI Band 6L

Species	Frequency (GHz)	Priorities				
		Galaxies	Solar System Bodies	ISM	Star formation	Stellar evolution
FeH	1411.1				3	
H_2O	1440.782					
N^+	1461.134			2		
CH	1470.689				3	
D_2H^+	1476.6				3	
CH	1477.292					
CO	1496.923	3		2	3	
H	1532.6				3	
^{13}CO	1540.988					
CO	1611.793					
HDO	1625.408		2		3	
$H_2{}^{18}O$	1633.484				3	
H_2O-*ortho*	1649.00				3	
CO^+	1649.309				3	
CO^+	1649.582					
^{13}CO	1650.767			2		
H_3O^+	1655.813		1 (comet)	3	3	
$H_2{}^{18}O$-*ortho*	1655.868			3	3	
CH	1656.961			2		
H_3O^+	1657.236			3		
H_2O-*ortho*	1661.011	3	2 (comet)	2		2
CH	1661.107					
$H_2{}^{17}O$-*ortho*	1662.464				3	
H_3O^+	1663.584				3	
CH^+	1669.1590		1 (comet)	3	3	2
H_2O-*ortho*	1669.905	3	2 (planet & comet)	3	3	2

HIFI Band 6H

Species	Frequency (GHz)	Priorities				
		Galaxies	Solar System Bodies	ISM	Star formation	Stellar evolution
H_2O-*ortho*	1713.940					1
H_2O-*ortho*	1716.765		1(planet)/2(comet)	2		1
H_2O-*para*	1717.037				3	1
$H_2{}^{18}O$	1719.250				3	
CO	1726.602			2		
H_2O-*para*	1753.173					2
H_2O-*ortho*	1753.888					2
^{13}CO	1760.486					1
H_2O-*para*	1762.131					2
NH_3	1763.525				1	
H_2O-*para*	1766.121					2
HCN	1769.876					1
H_2O-*para*	1794.753					1
H_2O-*ortho*	1794.735					1
H_2O-*para*	1794.830					1
H_2O-*ortho*	1797.238					1
O_3	1808.082					
HDO	1818.530					
OH	1834.735		2 (planet & comet)		3	
OH	1837.747		2 (comet)		3	
CO	1841.346			2	3	1
H_2O-*ortho*	1866.301					2
H_2O-*ortho*	1867.825					2
^{13}CO	1870.141					
$H^{13}Cl$	1873.410					
HCl	1876.230		3			
H_2O-*para*	1879.720					2
C_3	1890.558			2		
C_3	1896.706			2		
$^{13}C^+$	1900.1				3	
C^+	1902.346	3		3	3	2
H_2O-*ortho*	1903.697					2
H_2O-*para*	1903.875					2
H_2O-*para*	1904.495					2
C_3	1906.337			2		

C_3	1914.274			2		
H_2O-*ortho*	1918.477					2
H_2O-*para*	1919.372					2
CO	1956.018					