HIFI Spectral Scan of IRAS 15194-5115: a sneak peek

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Abstract

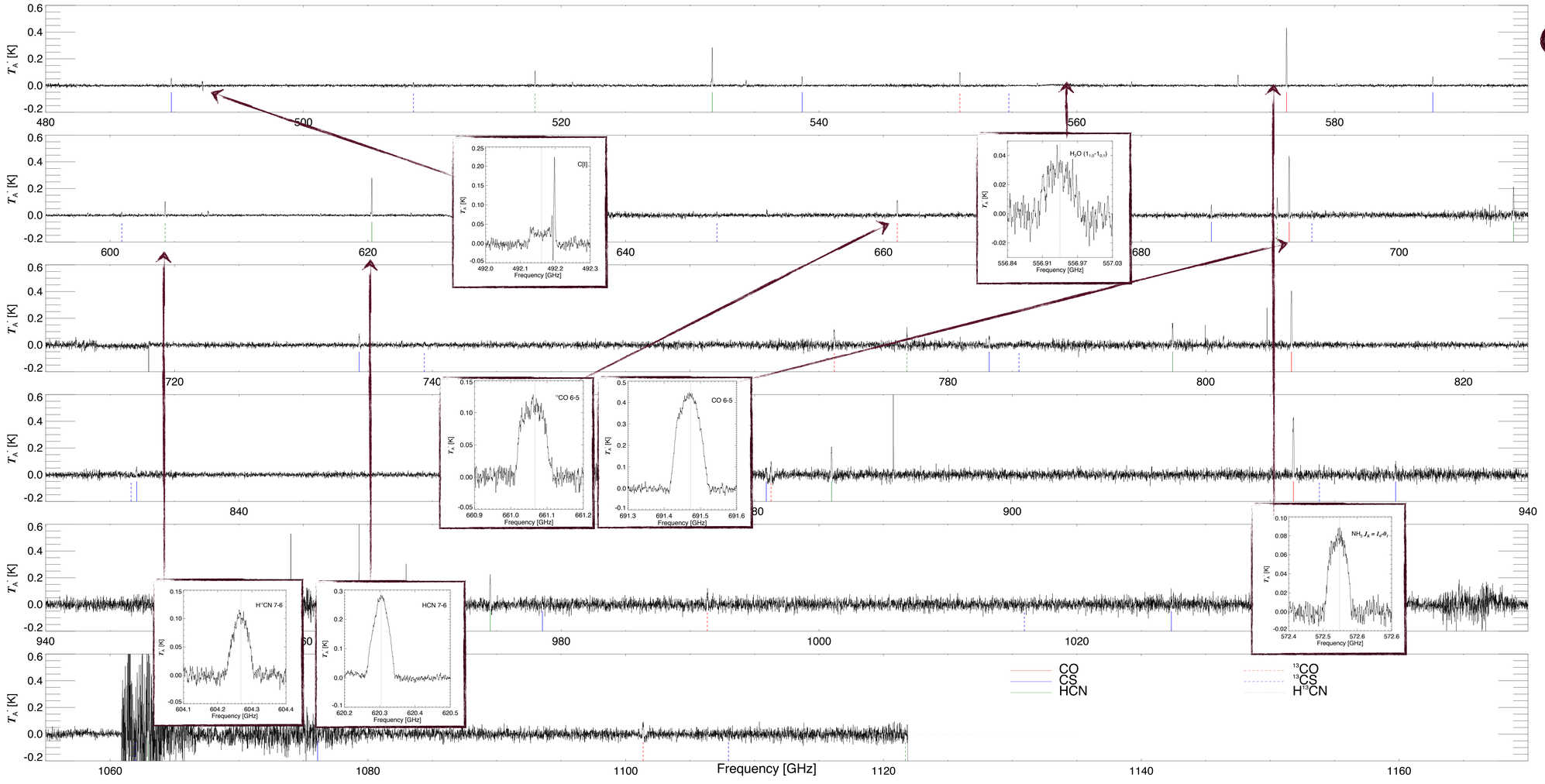
Broadband spectral surveys of individual sources are powerful tools to study the chemical complexity of the atmospheres and circumstellar envelopes (CSEs) of asymptotic giant branch (AGB) stars. We present here a full spectral survey with HIFI in the range 480-1120 GHz of the high mass-loss rate carbon star IRAS 15194-5115 (II Lup). Similar surveys have so far only been made of IRC +10216. A crucial difference to IRC +10216 is that IRAS 15194-5115 has a carbon isotopic ratio $^{12}C/^{13}C \approx 4$. This implies that it is a massive AGB star, with a main sequence mass above ~4.5 solar masses which has gone through hot bottom burning (HBB). Post-HBB stars are rare, emphasizing the importance of this survey. We will investigate the efficiency of various chemical processes and their dependence on the evolution of the object. A comparison between isotopic ratios determined for IRAS 15194-5115 and IRC +10216 is of special interest since these stars have most likely taken different evolutionary paths along the AGB. This study will set constraints on the nucleosynthesis and different mixing processes inside the star. The HIFI data will be complemented with spectral scans from APEX, Mopra, and PACS, extending the observed spectral range from 85 to 5400 GHz. It will be one of the most comprehensive studies of the molecular circumstellar environment around an evolved star, and answer questions about the evolution of AGB stars, and the chemical enrichment of their CSEs, the interstellar medium, and galaxies.

Preliminary results

At first glance, ~20 species, such as CO, HCN, CS, SiS, SiO, and several of their isotopologues can be identified.

Peak intensity ratios of the abundant species CO, HCN, and CS lead to a derived carbon isotopic ratio consistent with the published value of ~4:

Molecules	#lines	Transitions	Peak intensity ratios
$^{12}CO/^{13}CO$	5	J = 5-4 ... 9-8	3.0 - 4.5
$^{12}CS/^{13}CS$	10	J = 11-10 ... 20-19	1.2 - 5.3
$H^{12}CN/H^{13}CN$	6	J = 6-5 ... 11-10	1.3 - 2.7



Data

The data were retrieved from the Herschel Science Archive (HSA), inspected, and deconvolved after rejecting bad scans. Some parts of the spectrum - mainly bands 3b, 4a, and 4b - currently suffer from high noise and/or bad baseline stability. This will be dealt with in further careful data reduction steps.

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Figure: The full HIFI survey of IRAS 15194-5115 with insets of selected lines of C[I], NH_3, H_2O, CO, ^{13}CO, HCN, and H^{13}CN.

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