PROBING THE CHEMISTRY AND DYNAMICS OF HOT MOLECULAR CORES USING HIGHLY EXCITED CYANOPOLYYNIC TRANSITIONS

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A hyperfine line fitting program is presented, which decomposes an observed rotational transition into its individual hyperfine components. The fit is optimized by the use of the Levenberg-Marquardt algorithm (for non-linear fitting) or Caruana's algorithm (linearization of the Gaussian function). From the optimal fit, various parameters from the decomposed components are derived such as the linewidth dispersion, peak brightness temperature and peak position in velocity units. The closeness in frequency units of two neighbouring hyperfine components within a rotational transition spectrum allows the derivation of a more credible estimate of the optical depth for the observed source of emission. Effective smoothing of the data subsequent to the fitting procedure greatly reduces the perceived error in the determination of various physical conditions of the observed region. The technique has been employed in observations of massive hot molecular cores (HMCs), considered to be the birthplace of high mass stars. In particular, observations of the cyanopolyynes HC_3N and HC_5N, each of which include a quadrupole hyperfine structure, as well as methyl cyanide, CH_3CN, have been analysed with this technique and modelled with a radiative transfer code incorporating non-LTE conditions, in order to derive abundances and column densities for a total of 10 HMCs and 5 massive cores. Using these derived parameters for each core, we have been able to test the time-dependent chemical models presented for these species by Chapman et al. (2009) and thus verify the suitability of their usefulness as "chemical clocks" by which to constrain the ages of the observed objects. In addition to this work, a detailed study of the magnetic hyperfine structure of a selection of inversion transitions of NH_3 is presented. As part of the continuing preparatory work for Herschel, SOFIA and, in particular, ALMA - improved rest frequencies for this commonly used kinetic temperature detecting species in star-forming cores will be forthcoming.