$\Delta^{DD}$ clumped isotope measurements at natural isotopic abundances with the MAT-253 ULTRA instrument

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Natural molecular hydrogen (H$_2$) has three stable isotopologues: HH, HD and DD. At random distribution, the abundance of the so-called “clumped” molecules (DD) is directly related to the D/H ratio. The clumped anomaly ($\Delta^{DD}$) is a measure of the difference between the actual D distribution among HD and DD molecules, and the random distribution.

The $\Delta^{DD}$ anomaly is independent from the classical isotopic signature $\delta^D$, and it is thus interesting as a potential new tracer for studying processes involving H$_2$. At thermodynamic equilibrium, $\Delta^{DD}$ has a strong dependence on temperature with a difference of about 200 $\%$ over the 0 – 1000 $^\circ$C range, and with a sensitivity of about 1 $\%$ per $^\circ$C at ambient temperatures.

The H$_2$ clumped isotope anomaly $\Delta^{DD}$ has never been measured at natural isotopic abundance. We will present a method for $\Delta^{DD}$ analysis using the new MAT-253 Ultra instrument at IMAU. The precision obtained for $\Delta^{DD}$ of 2-6 $\%$ is sufficient to observe the expected natural variability. H$_2$ equilibrated at different temperatures shows a dependence on temperature as expected from theoretical calculations, which validates our method.