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On the $^{17}O/^{18}O$ ratio of post-AGB sources: canonical and non-canonical populations

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Stellar evolution and nucleosynthesis models are fundamental tools to derive parameters of stars from elemental atomic and isotopic abundance ratios. For evolved stars, the C/O/N elemental ratios and the $^{12}C/^{13}C$ and $^{16}O/^{17}O/^{18}O$ isotopic ratios provide very significant constraints to the otherwise elusive initial mass of the stars. In the case of post-AGB sources, the chemical composition of their expanding circumstellar envelopes can be derived from sensitive observations of rotational lines of several molecular species in the millimetre and sub-millimetre radio domains. The initial mass of post-AGB sources is a fundamental parameter to establish correlations with the main properties of their post-AGB envelopes (mass, momentum, kinetic energy, shape) and progress in our knowledge of their formation and evolution. In these sources, the C/O ratio can be easily constrained from the detection of C-bearing and O-bearing molecules other than CO, while the $^{17}O/^{18}O$ ratio is also straightforwardly determined from the relative strength of the optically thin rotational lines of $C^{17}O$ and $C^{18}O$. However, the results obtained up to date are far from being clear.

In this presentation, we will review the status of the question, including new accurate $^{17}O/^{18}O$ ratio measurements for 13 targets, totalling 25 studied post-AGB envelopes: 15 O-rich sources (including the eight water fountains presented by Khouri *et al.* 2021) and 10 C-rich ones. Comparing the $^{17}O/^{18}O$ ratios and the C-rich/O-rich chemical composition with models for sources that have completed the AGB evolution, we find that for about 50% of the cases, observational data align with model predictions: these canonical sources include 50% of both O-rich and C-rich sources in the sample. As for the non-canonical sources, the O-rich ones, which present $^{17}O/^{18}O$ ratios above those expected for C/O < 1, can be explained by a premature interruption of their AGB evolution as a consequence of a quasi-explosive ejection of a large fraction of the initial mass. This hypothesis agrees with the suggestion that these envelopes form in the merging of common-envelope (or similar) events. The non-canonical C-rich sources, on the contrary, display $^{17}O/^{18}O$ ratios below the predictions for C/O > 1. We discuss possible explanations for this enigmatic behaviour, including the possibility that these sources are extrinsic C-rich stars, whose high C abundances result from previous mass accretion from a former higher mass C-rich AGB donor companion.

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