# Part 4. Detailed Chemical Abundances

## Section B. Poster Papers

Despina Hatzidimitriou fields questions during her SMC review.

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# On the Star-formation History in the LMC: Observations of the Interstellar $C^{18}O/C^{17}O$ Ratio

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## 1. Introduction

The re-cycling of gas between stars and the interstellar medium (ISM) leads to a gradual metal-enrichment of a galaxy. Accordingly, information on the chemical evolution of a galaxy, e.g., its star-formation history (SFH), is contained in the chemical composition of the ISM. In this context, the abundance ratio of the rare oxygen isotopes, $^{18}O/^{17}O$ (usually taken as the $C^{18}O/C^{17}O$ column density ratio), appears to be a particularly promising probe of the SFH. According to present understanding of stellar nucleosynthesis, $^{17}O$ is mainly produced in intermediate-mass stars (say a few to ten $M_{\odot}$) while $^{18}O$ is synthesised in massive stars (say $>10\,M_{\odot}$) (e.g., Prantzos et al. 1996). Thus, the $^{18}O/^{17}O$ abundance ratio possibly reflects the relative number of massive stars compared to intermediate-mass stars, and thereby (qualitatively) constrains the SFH in terms of the average star-formation rate (SFR) and the initial mass-function (IMF). However, it should be remembered that the stellar nucleosynthesis of $^{17,18}O$ is not yet fully understood, leaving room for other interpretations of the $^{18}O/^{17}O$ ratio.

## 2. Observations

We have detected the rotational $J = 2-1$ spectral line emission of the carbon monoxide isotopomers $^{13}CO$, $C^{18}O$ and $C^{17}O$ in five molecular clouds in the LMC. Four of them (N44BC, N113, N159W, N214DE) are associated with H II regions while the fifth (N132D) is associated with a supernova remnant. The $^{13}CO(J = 2-1)$ line was detected and upper limits to the $C^{18}O(J = 2-1)$ line were obtained in three additional clouds (N159S and 30Dor-10 in the SMC, and N27 in the SMC). In N27 also the $C^{17}O(J = 2-1)$ line was observed. The observations were conducted with the Swedish-ESO Submillimetre Telescope (SEST) located at La Silla, Chile.

## 3. Results

The abundance ratio estimates for N44BC, N113, N159S, N159W N214DE and N27 are given in Table 6 in Heikkilä et al. (1998), whereas $^{13}CO$ and $C^{18}O$ data in 30Dor-10 and $C^{17}O$ data in N27 can be found in Heikkilä et al. (1999). In N132D we estimate the $^{13}CO/C^{18}O$, $^{13}CO/C^{18}O$ and $C^{18}O/C^{17}O$ abundance ratios to be $25 \pm 8$, $44 \pm 20$ and $1.8 \pm 0.9$, respectively. The resulting averages in the LMC (five sources) then are $28 \pm 4$, $46 \pm 8$ and $1.6 \pm 0.3$, respectively. The $C^{18}O/C^{17}O$ in the LMC is significantly lower than in the Galactic ISM (by a factor of two) and in centres of starburst galaxies (by a factor of five).

## 4. Discussion

Provided that current theories of the the stellar nucleosynthesis of $^{17,18}O$ apply, the low $^{18}O/^{17}O$ ratio found in the LMC suggests that, in the past, massive stars have contributed only little to the metal enrichment of the ISM in the LMC. Such a dominance of less massive stars points towards *a low average SFR and a steep IMF in the LMC in the past.* This contrasts the present star-formation activity in some parts of the LMC, e.g., the 30 Dor area, where the SFR is clearly high and the IMF has been estimated to be close to Salpeter. On the other hand, Massey et al. (1995) have estimated a steep IMF for field stars in the Galactic halo, the LMC and the SMC. Hence, we suggest that *during a significant fraction of the past, stars in the LMC were born mainly as field stars rather than in clusters.* In fact, this agrees well with the apparent lack of medium-old (~3–14 Gyr) clusters in the LMC (e.g., Da Costa, these proceedings). Since the young clusters are more metal-rich than the old ones, the gas must have undergone metal-enrichment also during the era without cluster-formation. One may speculate that field stars possibly form due to a more gentle star-formation activity, whereas clusters originate from more violent processes, such as starbursts.

Moreover, our data indicates a correlation between the $^{18}O/^{17}O$ ratio and metallicity. This can be tested by observations of molecular clouds in the SMC. To date, we have obtained only upper limits to the $C^{17,18}O$ line emission in the SMC.

Finally, since the observed clouds are located in different parts of the LMC, the $^{18}O/^{17}O$ ratio appears to be rather constant spatially, implying a well-mixed ISM and/or a star-formation activity that took place globally, perhaps induced by a tidal interaction or by a large-scale gas-instability.

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