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Are oxygen and neon enriched in PNe and is the current solar Ne/O abundance ratio underestimated?

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ABSTRACT

A thorough critical literature survey has been carried out for reliable measurements of oxygen and neon abundances of planetary nebulae (PNe) and H II regions. By contrasting the results of PNe and of H II regions, we aim to address the issues of the evolution of oxygen and neon in the interstellar medium (ISM) and in the late evolutionary phases of low- and intermediate-mass stars (LIMS), as well as the currently hotly disputed solar Ne/O abundance ratio. Through the comparisons, we find that neon abundance and Ne/O ratio increase with increasing oxygen abundance in both types of nebulae, with positive correlation coefficients larger than 0.75. The correlations suggest different enrichment mechanisms for oxygen and neon in the ISM, in the sense that the growth of neon is delayed compared to oxygen. The differences of abundances between PNe and H II regions are mainly attributed to the results of nucleosynthesis and dredge-up processes that occurred in the progenitor stars of PNe. We find that both these α-elements are significantly enriched at low metallicity (initial oxygen abundance $\lesssim$8.0) but not at metallicity higher than the Small Magellanic Cloud (SMC). The fact that Ne/O ratios measured in PNe are almost the same as those in H II regions, regardless of the metallicity, suggest a very similar production mechanism of neon and oxygen in intermediate-mass stars (IMS) of low initial metallicities and in more massive stars, a conjecture that requires verification by further theoretical studies. This result also strongly suggests that both the solar neon abundance and the Ne/O ratio should be revised upwards by ∼0.22 dex from the Asplund, Grevesse & Sauval values or by ∼0.14 dex from the Grevesse & Sauval values.

Key words: ISM: abundances – H II regions – planetary nebulae: general.

1 INTRODUCTION

It is generally assumed (e.g. Henry 1989) that α-elements, such as oxygen and neon, are not altered significantly by the various nucleosynthesis and dredge-up processes that occurred during the late evolutionary stages of low- and intermediate-mass stars (LIMS), which range in mass from about 0.8 to 8 $M_{\odot}$. Therefore, the abundances of α-elements measured in the descendants of LIMS, such as asymptotic giant branch (AGB) stars and planetary nebulae (PNe), should reflect the metallicity, Z, of the interstellar medium (ISM), from which the parent stars were formed. Under the assumption, abundances determined for PNe have been widely used to constrain the chemical evolution of the Milky Way and of nearby galaxies.

Recently, there is however some observational evidence that the above assumption is questionable, especially in low Z galaxies, where it has been found that oxygen abundances of PNe are higher than the average value of H II regions [e.g. Small Magellanic Cloud (SMC) and Large Magellanic Cloud (LMC); Leisy & Dennefeld 1996, 2006]. The enrichment of oxygen in PNe in lower metallicity environments becomes more apparent by comparing the Magellanic Clouds and the Galaxy. On the other hand, oxygen destruction has been found in PNe evolved from massive progenitors [e.g. NGC 6302; Pottasch & Beintema 1999; we define the progenitor stars which were initially more massive than about 5 $M_{\odot}$ as massive progenitors, where the ON (oxygen–nitrogen) cycle begins to occur]. There is also evidence that asymmetric PNe may be enriched in neon, as suggested by the observed relationships between the abundances and morphological types of PNe (Corradi & Schwarz 1995; Stanghellini et al. 2000).

The various nucleosynthesis [e.g. the hot bottom burning (HBB)] and dredge-up processes occurred in the late evolutionary epochs of LIMS, which eventually determined the chemical composition of the ejected nebulae. These depend strongly on the initial metallicity as well as mass. Recent theoretical calculations have indeed revealed several channels of altering oxygen and/or neon abundances

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by some processes that occurred in the PN progenitors. Oxygen destruction, for example, can occur through the CNO (carbon–nitrogen–oxygen) cycle specifically via the ON cycle in massive progenitors, while the third dredge-up can efficiently modify the nebular oxygen abundance by transporting the freshly manufactured material to the stellar surface. Charbonnel (2005) emphasized that the surface abundance of oxygen in massive progenitors is a result of competition between the efficiencies of the third dredge-up (for production) and the HBB (for destruction). We note that neon production may also become significant for a narrow range of stellar mass (Karakas & Lattanzio 2003).

One of the purposes of the current study is to clarify whether oxygen and neon abundances are significantly modified in LIMS and if so, the modifications that affect our current understanding of the chemical evolution of galaxies. To address this issue, we have collected all recent reliable determinations of oxygen and neon abundances of PNe and H II regions and present a thorough analysis of available data in this Letter.

As a consequence of the application of a time-dependent three-dimensional (3D) hydrodynamical model of the solar atmosphere in place of the earlier one-dimensional (1D) model, the metal content in the solar convection zone has been reduced by almost a factor of 2. Amongst them, abundances of key elements C, N and O have been lowered by approximately 0.2–0.3 dex from the earlier widely adopted values (see a review by Asplund, Grevesse & Sauval 2005, hereafter AGS05). However, those large downward revisions have caused serious conflicts with other solar physics studies. To fit the helioseismological measurements, for example, Bahcall, Basu & Serenelli (2005) suggested that the neon abundance needs be raised from 7.84 to 8.29 or the Ne/O ratio from 0.15 to 0.42. Recent *Chandra* measurements of 21 nearby solar-type stars by Drake & Testa (2005) concluded that the solar Ne/O ratio should be around 0.41. Finally, observations of Galactic PNe yield an average Ne/O ratio of about 0.25 from collisionally excited lines (Wang & Liu 2007). As we shall show in Section 3, the depletion or enrichment of oxygen in PNe is insignificant at solar metallicity. Thus accurate determinations of oxygen and neon abundances of PNe and H II regions can be used to constrain and calibrate solar oxygen and neon abundances and their ratio. This serves as the goal of the current Letter.

The Letter is organized as follows. In Section 2, we present our critical literature survey. In Section 3, we compare the oxygen and neon abundances in PNe and in H II regions and discuss their possible evolution mechanisms and histories. In Section 4, we discuss the neon abundances and the Ne/O ratio in the Sun. In the last section, we conclude by summarizing the main results.

2 THE DATA

Henry (1989) found a tight linear correlation between the Ne/H and O/H abundances for the Galactic, Magellanic and M31 PNe. Similar results have also been obtained by Henry, Kwitter & Balick (2004) for a sample of 86 Galactic PNe, by Stanghellini et al. (2006) for a sample of 79 Galactic PNe and by Wang & Liu (2007) for a sample of 25 Galactic bulge PNe and 58 disc PNe. A linear regression for the four samples yields slopes of 1.16 ± 0.04, 1.18 ± 0.095, 1.14 ± 0.09 and 1.21 ± 0.08, respectively. The tight correlation has been interpreted as a direct consequence of the fact that both neon and oxygen originate from primary nucleosynthesis in massive stars (MS; $M \gtrsim 10\,M_{\odot}$) and are therefore independent of the evolution of LIMS, the progenitors of PNe. On the other hand, it somehow seems strange that all those slopes are consistently larger than unity, implying that the growth of oxygen and of neon may not occur concurrently or at the same rate. Wang & Liu (2007) further examined this important issue by calculating the average Ne/O abundances of the SMC and LMC PNe, using the data published by Leisy & Dennefeld (2006). The average Ne/O ratios of 37 SMC PNe and 120 LMC PNe are 0.154 and 0.183, respectively, significantly lower than the corresponding values of 0.24 and 0.25 for the Galactic disc and the bulge samples, respectively (cf. section 7.3 in Wang & Liu 2007). The mean oxygen abundances of PNe in the SMC, LMC, Galactic disc and bulge are 8.09, 8.38, 8.60 and 8.70, respectively. It is clear that the Ne/O ratio and the oxygen abundance are positively correlated.

To further explore this critical issue, we have carried out a thorough literature survey of available measurements of oxygen and neon abundances of PNe and H II regions. The results are listed in Table 1 and plotted in Fig. 1. In addition to the Local Group galaxies, a sample of nearby dwarf irregular (dIrr) galaxies studied by van Zee & Haynes (2006) and a sample of blue compact galaxies (BCD) by Guseva et al. (2007) are also included. For galaxies with more than one available reference, the one with the largest number of objects or the most reliable data are used. The name of the host

Table 1. Oxygen and neon abundances on a logarithmic scale where H = 12 and Ne/O ratios for PNe and H II regions. Numbers in parentheses are the standard errors of the mean. (In cases where the sample contains only one object, the measurement errors are given instead.)

	N (obj)	O/H	Ne/H	Ne/O	Refs
PNe					
Leo A	1	7.30(0.05)	6.38(0.11)	0.12(0.03)	1
Sextans A	1	8.00(0.10)	6.70(0.20)	0.05(0.03)	2
Sextans B	5	7.96(0.15)	7.24(0.15)	0.20(0.04)	2
NGC 3109	6	8.16(0.19)	7.24(0.42)	0.14(0.03)	3
NGC 6822	6	8.01(0.13)	7.32(0.35)	0.20(0.03)	4
SMC	37	8.10(0.05)	7.27(0.08)	0.15(0.01)	5
LMC	120	8.38(0.03)	7.65(0.04)	0.18(0.01)	5
M31	12	8.40(0.09)	7.65(0.11)	0.19(0.01)	6
Gal. halo	9	7.99(0.07)	7.10(0.16)	0.20(0.08)	7
Gal. disc	58	8.60(0.02)	7.99(0.04)	0.24(0.01)	8
Gal. bulge	25	8.70(0.03)	8.13(0.04)	0.25(0.02)	8
H II regions					
Sextans A	4	7.47(0.12)	6.68(0.12)	0.16(0.02)	2
Sextans B	3	7.63(0.03)	6.83(0.17)	0.18(0.05)	2
NGC 3109	10	7.77(0.07)	6.84(0.10)	0.13(0.01)	3
dIrr	27	7.84(0.04)	7.06(0.04)	0.17(0.01)	9
BCDs	53	7.91(0.03)	7.15(0.03)	0.18(0.01)	10
SMC	6	8.03(0.06)	7.27(0.20)	0.17(0.11)	11
NGC 6822	2	8.05(0.05)	7.31(0.04)	0.18(0.01)	12
NGC 5253	4	8.24(0.04)	7.53(0.04)	0.19(0.01)	13
M33	6	8.27(0.02)	7.57(0.02)	0.20(0.01)	14
LMC	4	8.35(0.06)	7.61(0.05)	0.18(0.03)	11
M51	7	8.58(0.03)	7.91(0.09)	0.24(0.04)	15
Orion	1	8.60	8.00	0.25	16
Solar		8.66	7.84	0.15	17
Solar		8.83	8.08	0.18	18

References: 1 – van Zee, Skillman & Haynes (2006); 2 – Magrini et al. (2005); 3 – Peña, Stasińska & Richer (2007); 4 – Richer & McCall (2007); 5 – Leisy & Dennefeld (2006); 6 – Jacoby & Ciardullo (1999, excluding PN F57, 455 and 470); 7 – Howard, Henry & McCartney (1997); 8 – Wang & Liu (2007, from CELs); 9 – van Zee & Haynes (2006); 10 – Guseva et al. (2007); 11 – Russell & Dopita (1990); 12 – Peimbert, Peimbert & Ruiz (2005); 13 – López-Sánchez et al. (2007); 14 – Crockett et al. (2006); 15 – Bresolin et al. (2004); 16 – Simpson et al. (2004); 17 – AGS05; 18 – GS98.

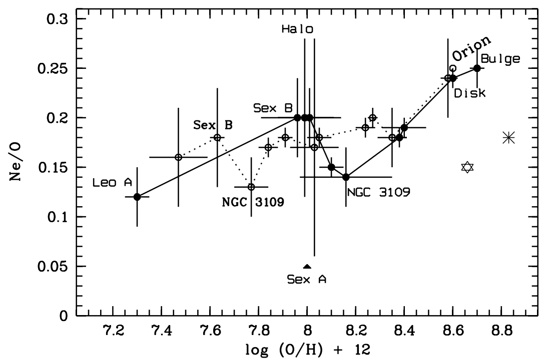

Figure 1. The mean Ne/O abundance ratios plotted against the average oxygen abundances derived from H II regions (open symbols) and from PNe (filled symbols) in nearby galaxies. The star and asterisk stand for the solar values given by AGS05 and by GS98, respectively. Names of several sources are marked. Different types of sources are linked by lines to aid visualization.

galaxy and the region sampled, the number of objects in each sample, the mean Ne/O, O/H and Ne/H values and the data reference are given in columns 1–6 of Table 1, respectively. For each sample, only those objects with electron temperature (hereafter T_e) measured from the direct method are included to ensure the reliability of the abundance determinations. The numbers given in parentheses are the corresponding standard errors of the mean, except for samples consisting of a single object, for which the measurement errors are given instead. For the Orion Nebula, no errors are given in Esteban et al. (1998) for the abundances deduced. For comparison, the solar values from AGS05 and Grevesse & Sauval (1998, hereafter GS98) are listed in the last two rows, respectively.

3 OXYGEN AND NEON ABUNDANCES OF PNE AND OF H II REGIONS

The data collected from the current survey corroborate the previous findings. First, a linear regression of the mean abundances of neon and oxygen tabulated in Table 1 yields slopes of 1.21 ± 0.03 and 1.14 ± 0.01 with correlation coefficients of 0.98 and 0.89, for samples of PNe and H II regions, respectively. The slopes agree well with the previous results described above. Secondly, it is clear that for both samples the Ne/O ratio increases with increasing oxygen abundance, with a linear correlation coefficient larger than 0.75. Also in both types of objects, we see a discontinuity in the overall positive correlation. Remarkably, this discontinuity occurs between Sextans B and NGC 3109 for both PNe and H II regions. In the above regression analysis, we have excluded the PNe data point of Sextans A, which contains only one object with an abnormally low Ne/O ratio, probably caused by measurement errors.

We should emphasize that the positive correlation is possibly not introduced by the hardening of spectra in low metallicity nebulae. We have constructed a set of eight ideal photoionization models using the code CLOUDY (Ferland et al. 1998) with typical input parameters for PNe, varying only the oxygen abundance from 8.7 to 7.0 or the effective temperature of ionizing star from 75 000 to 200 000 K. The derived Ne/O ratios based on the output line intensities and ionization correction factors (ICFs) are nearly constant for all the models, with the largest variation only about 10 per cent. This is reasonable given the similarities of ionization potentials of oxygen and neon. To obtain an estimate of systematic errors involved in the individual samples studied in this Letter, we used our methods to recalculate the Ne/O ratios and oxygen abundance for several samples based on the line intensities published in the original papers. Our new O/H and Ne/O ratios are consistent with the published values and no evident bias is found.

The positive correlation between Ne/O and O/H observed in H II regions indicates a different enrichment history of neon and oxygen in the ISM. That is, the enhancement of neon lags behind oxygen, coinciding with the current theory of nucleosynthesis of MS. Kobayashi et al. (2006, hereafter K06) have calculated the evolution of heavy-element abundances, adopting their own new nucleosynthesis yields. Table 3 of K06 gives yields of Type II supernovae and hypernovae integrated over a Salpeter initial mass function (IMF) for different metallicities. The average oxygen abundance for Sextans A determined from H II regions is 7.47, corresponds to a metallicity $Z \sim 0.001$, at which K06 predict a Ne/O ratio of 0.17, consistent with the observed average value in this galaxy. At solar metallicity, the K06 predict a Ne/O ratio of 0.28, again close to what observed in the Orion Nebula and in M51. The agreement between the observations and the theoretical predictions of K06 is remarkable. In this comparison we have however neglected the contributions of Type Ia supernova to the evolution of O, Ne and S, which are not all negligible.

The case of PNe is more complex. As described earlier, oxygen can be either manufactured or destroyed during the late evolutionary stages of LIMS. From Table 1 and more obviously from Fig. 2, we find that for four relatively metal-rich and massive galaxies, the Milky Way, LMC, SMC and NGC 6822, oxygen and neon abundances measured in PNe are almost identical to those found in H II regions. For the less massive and more metal-poor galaxies, NGC 3109, Sextans B and Sextans A, the oxygen and neon abundances obtained for PNe are significantly higher than those determined for H II regions, and the differences increase as the metallicity decreases. The trend is similar for both oxygen and neon, leading to small differences in the Ne/O abundance ratios at all metallicities. The only exception is the neon abundance of the single PN in Sextans A, which is probably erroneous due to observational uncertainties.

It is clear from the above result that the synthesis of oxygen and neon in LIMS occurs only at low metallicities, and that the amount of oxygen and neon synthesized seems to be comparable. When oxygen abundance reaches about 8.0 or higher, the manufacture of oxygen and neon in LIMS diminishes. That the yield of oxygen increases in low metallicity environments has also been found previously by Leisy & Dennefeld (2006) and is supported by theoretical

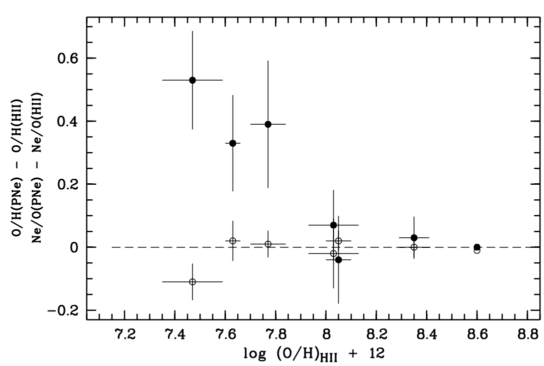

Figure 2. The differences between oxygen abundances (filled circles) and the Ne/O ratios (open circles) of PNe and of H II regions are plotted against the mean oxygen abundances of H II regions in seven galaxies. From left to right, they are Sextans A, Sextans B, NGC 3109, SMC, NGC 6822, LMC and the Galaxy, respectively.

calculations of Marigo (2001). The latter author shows that the net yield of ^{16}O is positive for stars of initial masses between ∼0.8 and ∼3.5 M$_{\odot}$, thanks to the dredge-up events during the thermal-pulse AGB (TP-AGB) phase, and that the yield increases with decreasing metallicities due to higher efficiency and longer durations of the TP-AGB phase.

We emphasize that although PNe in NGC 6822 have mean oxygen and neon abundances comparable to PNe in Sextans A, B and NGC 3109, PNe in NGC 6822 may have experienced a different chemical enrichment history compared to those in the latter three galaxies. It seems that oxygen and neon are not enhanced in PNe of NGC 6822 but both elements are significantly enhanced in PNe of the latter three galaxies. Therefore, if PNe of a galaxy are measured to have an oxygen abundance close to 8.0, this abundance value can either result from a progenitor abundance lower than 7.8 but then enhanced to the observed value during the late evolutionary stages of the progenitor star, as in the case of Sextans B. The abundance can however reflect the true metallicity of the ISM from which the PN was formed, as in the case of NGC 6822.

On the other hand, we find that oxygen destruction in the progenitor stars of PNe is insignificant and does not affect the mean oxygen abundance of PNe, though this phenomenon has been observed occasionally in some PNe evolved from massive progenitors. This is consistent with the current theoretical predictions. Model calculations by Karakas (2003) show that oxygen destruction takes place only in stars more massive than 5 M$_{\odot}$ of initial metallicities from $Z = 0.004$ to 0.008 or in stars of initial masses between 6 and 6.5 M$_{\odot}$ at solar metallicity. What's more, in the former case, the star will also exhibit high N/O ratios, inconsistent with the observations. Clearly, oxygen destruction occurs only rarely and hardly affects the mean oxygen abundance of PNe in nearby galaxies. For more distant galaxies, the effect can be more significant as the observations may be biased towards PNe descended from more massive stars in which oxygen destruction can be more important.

The consistency between Ne/O ratios observed in PNe and in H II regions of the same host galaxies (excluding Sextans A), as shown in Fig. 2, strongly suggests that the Ne/O ratio is not altered by the late-stage evolution of LIMS. That means, oxygen and neon are either hardly modified or altered by comparable amounts in LIMS. The higher neon and oxygen abundances of PNe compared to those of H II regions in NGC 3109 and the Sextans galaxies seem to indicate the occurrence of the latter scenario in metal-poor environments. In galaxies of higher metallicities, such as the LMC and the Galaxy, there is no evidence of enhancement of oxygen and neon.

It is beyond the expectation of the current theory of nucleosynthesis of LIMS that neon is enriched by amounts comparable to those of oxygen at low metallicities. Detailed stellar evolutionary calculations for compositions appropriate to the Galaxy and LMC by Karakas & Lattanzio (2003) have shown that neon production becomes significant only in a narrow mass range, from about 2 to 4 M$_{\odot}$ (lower for lower metallicities), where ^{22}Ne is synthesized by two α-captures on to ^{14}N in sufficient quantities to affect the total neon abundance by more than 20 per cent. Marigo et al. (2003) also suggest a sizeable Ne production in intermediate-mass stars of the LMC composition. Although some oxygen enrichment is expected to occur in a similar mass range, the production of the two α-elements proceeds via different channels. ^{16}O is synthesized mainly from ^{12}C via α-capture reactions and possibly to a minor degree from ^{13}C with neutrons as by-products, whereas ^{22}Ne is mainly synthesized from ^{14}N. As such it is difficult to understand why oxygen and neon are enhanced by comparable amounts. More detailed theoretical calculations are highly desired.

4 THE SOLAR NEON ABUNDANCE

The uncertainty of solar neon abundance is intrinsically large. It is generally determined by observing the outer regions (such as corona) of the Sun, and relies on the relative abundance of neon with respect to oxygen or magnesium assuming that relative abundance ratios in the corona are equal to the photospheric values. From the ratio of Ne/O (Ne/Mg) and the photospheric abundance of oxygen (magnesium), one can deduce the photospheric absolute abundances of neon. However, this method suffers from large potential uncertainties when applying corrections to account for the first ionization potential (FIP) effects, especially when employing the ratio of Ne/Mg, as magnesium is a low FIP element and oxygen and neon are not. The current best estimates of the solar Ne/O ratio and neon abundance obtained from this method are 0.15 and 7.84, respectively (cf. AGS05). However, this very low Ne/O ratio, when combined with the much reduced photospheric oxygen abundance obtained from the application of a time-dependent 3D hydrodynamical model of the solar atmosphere (AGS05), runs into serious conflict with the current best solar model. For example, Bahcall et al. (2005) showed that helioseismological measurements require a Ne/O ratio as high as ∼0.4. Interestingly, recent observations and analyses of a sample of nearby solar-like stars by Drake & Testa (2005) also support a high Ne/O ratio of about 0.4.

Recently, Basu & Antia (2008) have examined possibilities which could reconcile the large discrepancies between the Sun and models constructed with the AGS05 abundances. They show that the discrepancies are too large to be accounted for by potential uncertainties in the opacity calculations. Increasing the diffusion does not help much either. Raising the neon abundance is probably the best choice to increase the opacity in order to compensate for the reduction in oxygen abundance yet not introduce other inconsistencies. According to their calculations, raising the neon abundance by a factor of 4 or 2.5 (the latter value is obtained by increasing the abundances of C, N and O by 1σ uncertainties), which corresponds to a Ne/O ratio of 0.6 and 0.4, respectively, could compensate for the reduction in the oxygen abundance. Although, these values appear too high to be supported by the available measurements, even though it is quite possible that there are other factors affecting the analysis, their calculations do suggest raising the neon abundance, if the solar photospheric abundances of other abundant second-row elements recommended by AGS05 are indeed correct.

The Ne/O ratios observed in PNe and H II regions provide important clues to the solar Ne/O ratio. Fig. 1 shows that the solar Ne/O abundance ratios (recommended by GS98 and by AGS05) are definitely too low compared to the mean ratio of ∼0.25 measured in Galactic disc PNe and H II regions, both having an average oxygen abundance comparable to the Sun. As concluded in the last section, there is no clear evidence of modification of Ne/O ratios during the late evolutionary stages of LIMS. Therefore, they should yield a Ne/O ratio comparable to the solar value. Hence, we strongly suggest that the current solar Ne/O value, and consequently also the absolute neon abundance, should be raised by a factor of 1.7, i.e. 0.22 dex, from the AGS05 values, or by a factor of 1.4, i.e. 0.14 dex, from the GS98 values.

We note that the depletion of oxygen on to dust grain is insignificant at solar metallicity and will not change the above conclusion. Simón-Díaz et al. (2006) have compared the oxygen abundance obtained from a detailed and fully consistent spectroscopic analysis of the group of B stars associated with the Orion Nebula with recent nebular gas-phase results. They found that they are in good agreement with each other and therefore the dust depletion is quite small ($\lesssim$0.02 dex) at the metallicity of Orion.

Rubin et al. (2008) have determined the Ne/S ratios for 25 low-metallicity, high-ionization H II regions in the Local Group spiral galaxy M33, based on *Spitzer* data by sampling the dominant ionization states of Ne (Ne^{+}, Ne^{2+}) and S (S^{++}, S^{3+}). Combined with other results (cf. their figs 11 and 12), the authors regarded their estimated total Ne/S ratio to be reliable. Their derived mean Ne/S ratios range from 10.1 to 16.3, much higher then the solar value of ~5 (AGS05), and consistent with the solar Ne/S ratio if Ne abundance alone is raised to 8.29, as suggested by Bahcall et al. (2005). The sharp contrast between their mean Ne/S ratio and the solar ratio strongly supports our conclusion here that the solar neon abundance is currently largely underestimated. Rubin et al. (2008) also noted the possibility that the true Ne/S ratio may be less for lower metallicity galaxies, in accordance with our other conclusion that the Ne/O ratio is less in lower metallicity galaxies, due to a delay of neon production at low metallicity.

5 CONCLUSION

In this Letter, we present a critical literature survey of recent measurements of oxygen and neon abundances of PNe and of H II regions in the Milky Way and other nearby galaxies. We find that there is significant oxygen and neon production in LIMS at metallicities lower than the SMC, but not at higher metallicities. We find that oxygen destruction is probably insignificant. We show that neon and oxygen are probably enhanced by the same amounts in PNe at low metallicities, a result not predicted by the current theory of nucleosynthesis for LIMS.

We find that the Ne/O ratio increases with increasing oxygen abundance in PNe and in H II regions, suggesting a different enrichment history of neon and oxygen in the ISM and thus probably different production mechanisms of these two α-elements in massive stars, as predicted by current theoretical calculations.

Both PNe and H II regions in the Galactic disc yield a consistent Ne/O ratio of 0.25, higher than the solar value of 0.18 (GS98) or 0.15 (AGS05). We suggest that the solar Ne/O ratio and the absolute neon abundance need to be revised upwards by about 0.22 dex from the values of AGS05 or by 0.14 dex from those of GS98. A recent discussion based on the Ne/S ratios measured in H II regions in nearby galaxies by Rubin et al. (2008) also points to an upward revision to the solar neon abundance.

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