The ^{32}S/^{33}S Abundance As A Function Of Galactocentric Radius In The Milky Way

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Astration of heavy elements by the stars of the Milky Way form a fossil record which may preserve spacial distribution of the mass function for the stars in the galaxy. Sulfur is among the last common element for which the relative abundance of its various isotopes have yet to be completely measured within our galaxy. Explosive oxygen burning in massive stars is thought to be the process which dominates sulfur production within stars (Arnett et al. 1970; Woosley et al. 1973; Thielemann et al. 1985). These models predict that the various isotopes (^{32}S, ^{33}S, ^{34}S) are formed in relative abundance which depend strongly upon the mass of the parent star. This relative abundance is thought to be unaffected by subsequent stellar processing since all important sinks of sulfur destroy it without regard for isotopic form. Hence the spacial variation of the mass function (MF) can be studied by measuring the abundance variation of sulfur isotopes in the galaxy provided that the product yields for these isotopes are known accurately as a function of stellar mass.

Here we report the measurement of [^{32}S]/[^{33}S] abundance ratio as a function of galactic radius. The J = 2 → 1 lines of ^{13}C^{32}S and ^{12}C ^{33}S at 92.49 and 97.17 GHz respectively were measured in eleven sources at various galactic radii during 1984 October and 1985 June using the cooled-Cassegrain Schottky diode mixer at the NRAO 12 m antenna on Kitt Peak, Arizona.[1] All data was taken with a 60" FWHM beam, position switching 15' in cross elevation. The spectra were dispersed in a 128 channel filter bank of 250 and 500 kHz resolution. In all cases the data from the same filter bank was used for both molecular species. For all sources except IRC +10°216, the two lines were observed sequentially at the same air mass on either side of the meridian transit. Furthermore, each object was observed at least on two separate nights. For the objects Sgr B2 and Sgr A the data in Table 1 and Fig. 1 is the weighted mean of the observations on different nights. Only the best nights data is presented for the other objects. The data for the evolved star IRC +10°216 was taken on separate nights and probably has an additional ±20% systematic uncertainty. Relative calibration was obtained by using a focal plane chopper wheel (Ulich and Haas 1976) while absolute calibration was found from periodic observations of Orion A taking T_R^* as 0.67 K and 0.39 K for ^{13}C^{32}S and ^{12}C^{33}S respectively. Peak antenna temperatures on this calibration object were repeatable to ±10% over the length of the observing run.

The results of the observation are presented in Table 1 along with the adopted values for [^{12}C]/[^{13}C]. Brightnesses for ^{13}C^{32}S were calculated by integrating over its seven fine structure lines. We assume that both these transitions are optically thin in all sources so that their corresponding molecular abundances are given by $\int \nu^{-2}\, T_R^*(\mathrm{CS})\, d\nu$.

Work is in progress to use this data to test current models of sulfur synthesis in high mass stars by requiring that their isotope product yields give physically reasonable MFs when compared to our measured abundances at each radius.

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TABLE 1

Object	α(1950)	δ(1950)	R [kpc]	$\int T_R^*(^{13}CS)dv$ [K-km s^{-1}]	$\int T_R^*(C^{33}S)dv$ [K-km s^{-1}]	$\frac{[^{13}CS]}{[C^{33}S]}$	$\frac{[^{12}C]}{[^{13}C]}$*	$\frac{[^{32}S]}{[^{33}S]}$
W3(OH)	2 23 17	61 39 00	12.2	1.4 ± 0.2	1.0 ± 0.2	1.4 ± 0.3	99 ± 17	137 ± 30
Ori A	5 32 47	-5 24 30	10.5	3.6 ± 0.2	3.1 ± 0.2	1.2 ± 0.1	50 ± 4	60 ± 7
Ori B	5 39 12	-1 55 42	11.0	1.6 ± 0.2	2.1 ± 0.2	0.8 ± 0.1	56 ± 8	45 ± 9
NGC 2264	6 38 25	9 32 29	11.1	1.6 ± 0.1	0.6 ± 0.1	2.8 ± 0.5	101 ± 22	283 ± 60
IRC+10°216	9 45 15	13 30 45	10.0	2.4 ± 0.3	0.1 ± 0.3	≥3.4 (2σ)		
Sgr A	17 42 42	-28 59 00	0	12.4 ± 0.5	4.6 ± 0.3	2.7 ± 0.2	26 ± 5	70 ± 14
Sgr B2	17 44 11	-28 22 30	0.1	16.8 ± 0.4	6.9 ± 0.4	2.4 ± 0.2	23 ± 3	55 ± 9
W33	18 11 19	-17 56 46	5.7	7.5 ± 0.3	4.9 ± 0.4	1.5 ± 0.1	42 ± 4	63 ± 7
M17	18 17 27	-16 14 54	8.0	4.5 ± 0.2	2.6 ± 0.3	1.7 ± 0.2	85 ± 14	145 ± 29
DR 21	20 37 13	42 08 51	9.9	1.4 ± 0.1	1.6 ± 0.2	0.9 ± 0.1	73 ± 11	66 ± 12
NGC 7538	23 11 37	61 12 00	12.7	1.6 ± 0.15	0.8 ± 0.2	2.0 ± 0.5	77 ± 21	154 ± 57

Notes: quoted uncertainties are ±1σ rms internal; systematic uncertainties are ±20%.

$$\frac{[^{13}CS]}{[C^{33}S]} = \frac{\int \nu^{-2} T_R^*(^{13}CS)dv}{\int \nu^{-2} T_R^*(C^{33}S)dv} , \qquad \frac{[^{32}S]}{[^{33}S]} = \frac{[^{13}CS]}{[C^{33}S]} \frac{[^{12}C]}{[^{13}C]}$$

*Langer et al. 1984

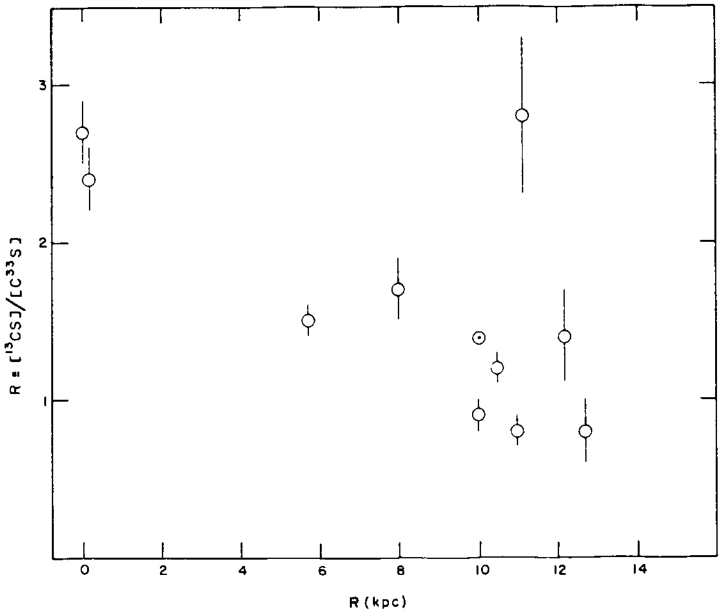

Figure 1

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