Planetary Nebulae: An Eye to the Future
Proceedings IAU Symposium No. 283, 2011
A. Manchado, L. Stanghellini & D. Schönberner, eds.

doi:10.1017/S1743921312011908

1D radiative transfer models of 21 and 30 μm emission features in proto-planetary nebulae

Chinnathambi Muthumariappan[1] **and Bacham E. Reddy**[2]

[1]Vainu Bappu Observatory, Indian Institute of Astrophysics, Kavalur, 635 701 India
email: muthu@iiap.res.in

[2]Indian Institute of Astrophysics, Koramangala, Bangalore 560 034 India
email: ereddy@iiap.res.in

Abstract. Spectral energy distributions of six proto-planetary nebulae showing 21 and 30μ features were fit with models obtained from 1D radiative transfer code, taking FeO and MgS respectively are the carriers of the features. Atomic abundances of these carrier materials were derived and they are lower or comparable to their stellar photospheric values. This stregthens the possibility of these materials to become the carriers of their respective features.

Keywords. stars: AGB and post-AGB, infrared: stars, radiative transfer

1. Introduction

21 and 30μ sources are carbon rich metal poor proto-planetary nebulae (PPNe) which show very large infrared excess (Hrivnak *et al.* 2009). These two features together make about 20% of the total IR energy emitted from these source. The nature of the carriers of these features are still unknown . An important criteria for a solid state grain to be a potential carrier of the IR feature is that the atomic abundances required to produce the emission feature in the circumstellar shell must be equal or smaller than their respective abundances available in the stellar photosphere. We have taken FeO and MgS as the carriers of 21 and 30 μ features respectively. With this we examine here the abundance budget in six well known PPNe by solving radiative transfer problem in their dust shells.

2. 1D radiative transfer models

We have taken six PPNe candidates namely IRAS 05341+0852, IRAS 07134+1005, IRAS 16594-4656, IRAS 19500-1709 , IRAS 22272+5435 and IRAS 23304+6147 for our study. Their SEDs were derived from archival data: photometric data were taken from SIMBAD (optical), 2MASS (near-IR), MSX and $IRAS$ bands (far-IR) and the low resolution spectroscopy data was taken from ISO archive. We used 1D Radiative Transfer code DUSTY to model the observed SEDs of these sources. We considered grains in the envelope constituted with amorphous carbon, FeO and MgS. The optical constants of MgS and FeO were taken respectively from Begemann *et al.* (1994) and Henning *et al.* (1995). Dust shell properties are listed in Fig. 1. Model fits to the data are shown in Fig. 2.

The atomic abundances locked-up in the carrier materials were derived from their mass fraction obtained from our models and compared with their respective values in the stellar photosphere. The required abundances are smaller than their published stellar photospheric values for most sources. For IRAS 07134+1005 and IRAS 2330+6147 the derived abundances were slightly higher than the photospheric values, however, the error in the estimation of circumstellar abundances could be upto 20%. This study hence

Object	T_{dust} K	Mg,S, Fe (ppm) CSE	Mg,S, Fe (ppm)Star	dM/dt $M_\odot$/year	M_{env} $M_\odot$
05341+0852	190	$9.9\mathrm{x}10^{-6}$	–	–	
		"			
		$2.3\mathrm{x}10^{-6}$	$5.57\mathrm{x}10^{-5}$	$3.79\mathrm{x}10^{-5}$	0.029
07134+1005	136	$1.00\mathrm{x}10^{-6}$	$4.36\mathrm{x}10^{-6}$		
		"	$4.17\mathrm{x}10^{-6}$		
		$5.0\mathrm{x}10^{-6}$	$3.24\mathrm{x}10^{-6}$	$4.39\mathrm{x}10^{-5}$	0.128
16594-4656	178	$6.95\mathrm{x}10^{-6}$	–		
		"			
		$4.60\mathrm{x}10^{-6}$	–	$1.55\mathrm{x}10^{-4}$	0.112
19500-1709	160	$5.96\mathrm{x}10^{-6}$	$1.66\mathrm{x}10^{-5}$		
		"	$7.41\mathrm{x}10^{-6}$		
		$2.31\mathrm{x}10^{-6}$	$8.12\mathrm{x}10^{-6}$	$4.16\mathrm{x}10^{-5}$	0.225
22272+5435	133	$3.97\mathrm{x}10^{-6}$	–		
		"	$1.41\mathrm{x}10^{-5}$		
		$1.15\mathrm{x}10^{-6}$	$1.44\mathrm{x}10^{-6}$	$3.66\mathrm{x}10^{-5}$	0.184
23304+6147	238	$7.95\mathrm{x}10^{-6}$	–		
		"	$9.55\mathrm{x}10^{-6}$		
		$6.15\mathrm{x}10^{-6}$	$5.25\mathrm{x}10^{-6}$	$6.89\mathrm{x}10^{-5}$	0.282

Figure 1. Dust shell parameters of the sample PPNe derived from our models.

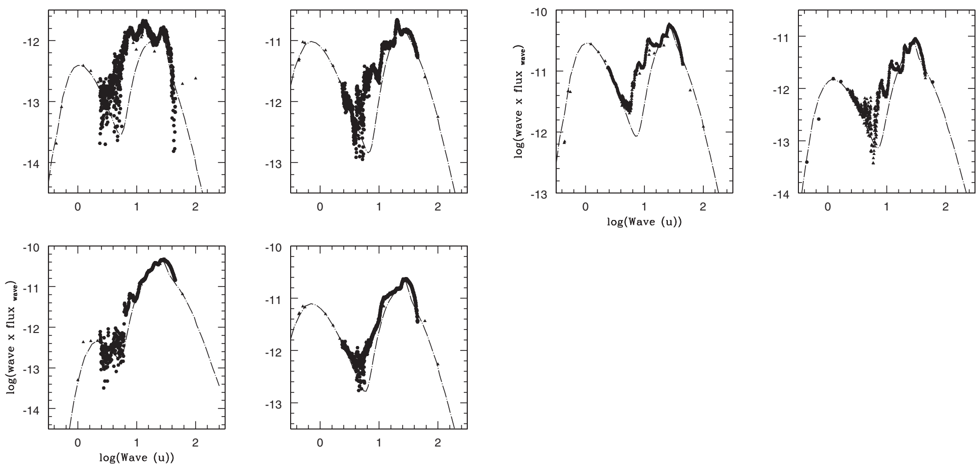

Figure 2. 1D radiative transfer model fit (solid lines) to the SEDs of the sample sources.

strengthens the possibility of FeO and MgS to become the potential carriers for the 21 and 30μm emission features respectively.

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https://doi.org/10.1017/S1743921312011908 Published online by Cambridge University Press