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Magnetic fields and radio emission processes in maser-emitting planetary nebulae

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Abstract. We present polarimetric observations of the 4 ground-state transitions of OH, toward a sample of maser-emitting planetary nebulae (PNe) using the Australia Telescope Compact Array. This sample includes confirmed OH-emitting PNe, confirmed and candidate H_2O-maser-emitting PNe. Polarimetric observations provide information related to the magnetic field of these sources. Maser-emitting PNe are very young PNe and magnetic fields are a key ingredient in the early evolution and shaping process of PNe. Our preliminary results suggest that magnetic field strengths may change very rapidly in young PNe.

Keywords. magnetic fields – masers – polarization – stars: AGB and post-AGB – planetary nebulae: general.

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1. Introduction

Previous polarimetric studies of a few OHPNe with single-dish telescopes shown that circularly polarized OH features are common in OHPNe, but the detection of Zeeman pairs is far more elusive (Szymczak & Gérard 2004, Wolak *et al.* 2012, Gonidakis *et al.* 2014). However, new interferometric observations have shown more promising candidates. The only OHPN in which Zeeman splitting has been clearly detected is IRAS 16333-4807 at 1720 MHz (Qiao *et al.* 2016), with a derived magnetic strength of $\simeq 11$ mG. Another possible Zeeman pair has been reported in K3-35 at 1665 MHz (Gómez *et al.* 2009), giving $B \simeq 0.9$ mG. Both objects are probably among the youngest PNe, since both are OH and H_2O maser emitters. Gómez *et al.* (2016) presented full-polarizations observations of the 4 OH transitions, toward 5 confirmed and 1 candidate OHPNe. We detected significant circular and linear polarization, in 4 and 2 objects, respectively. Possible Zeeman pairs were seen in JaSt 23 and IRAS 17393-2727, with magnetic field strengths 0.8−24 mG.

2. Observations and Results

New observations were carried out with the ATCA, in its 6A configuration, on 2017 February 13−14. We obtained data in full polarization (two linear polarizations and their corresponding cross-polarizations). Broadband continuum data cover a bandwidth of 2 GHz, centered at 2.1, 5.5 and 9 GHz. We also observed the OH ground-level transitions of rest frequency 1612, 1665, 1667, and 1720 MHz with a spectral resolution of 0.5 kHz ($\simeq 0.09\ \mathrm{km\ s^{-1}}$). For these observations, our main targets were IRAS 16333-4807 (I16333), IRAS 17393-2727 (I17393), and IRAS 18061-2505 (I18061). Radio continuum emission is detected in all three sources. We detected OH maser emission in I16333 and I17393, while no OH maser emission was detected (< 0.06 Jy) in I18061.

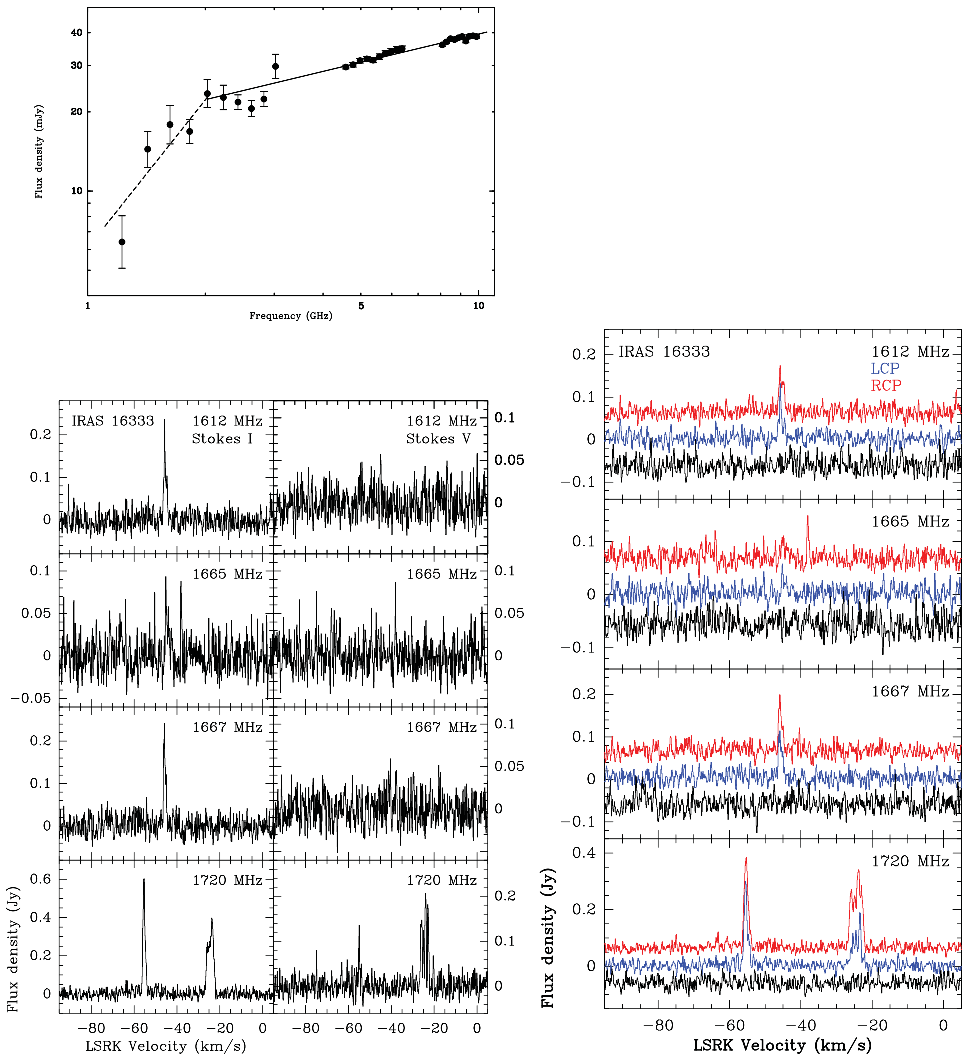

Figure 1. *Top left:* Flux density of I16333 as a function of frequency. The emission at < 2 GHz is optically thick (spectral index $\simeq 1.87$) and partially thick ($\simeq 0.36$) at higher frequencies. *Bottom left:* OH maser spectra in Stokes I and V. *Bottom right:* circular (red and blue) and linear (black) polarizations.

Here we present preliminary results of I16333 (Fig. 1). The flux densities are consistent with the values measured previously by Qiao *et al.* (2016). These spectra do not show a clear evidence of Zeeman pairs as in previous observations (Qiao *et al.* 2016). Our results may indicate a fast change in the magnetic field strength within a few years.

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