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To cite this article: M. Parthasarathy and S. K. Jain 2021 *Res. Notes AAS* **5** 212

Manuscript version: AAS-Provided PDF

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DRAFT VERSION SEPTEMBER 16, 2021
Typeset using L^AT_EX default style in AASTeX631

Polarization measurements of selected young stars with circumstellar dusty disks

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ABSTRACT

BVRI polarization measurements of 14 selected young stars with circumstellar dust disks are presented. The interstellar polarization in the direction of these stars is not significant. The observed polarization data and its wavelength-dependence indicate that it is intrinsic, due to scattering by circumstellar, asymmetric dusty disks/envelopes.

Keywords: Polarization-stars: circumstellar matter-stars: pre-main-sequence-stars: individual: Herbig Ae/Be-stars: protoplanetarydisks.

1. INTRODUCTION

Many of the pre-main sequence stars, Herbig Ae/Be stars and young stars have been found to have circumstellar disks, protoplanetary disks, shells/envelopes etc. Polarization measurements, particularly spectropolarimetry, is an important technique to understand these circumstellar disks/envelopes (Heiles 2000; Harrington & Kuhn 2009; Alecian et al. 2013). Most of the types of young stars have regular, irregular activity and variability and in their circumstellar disks/envelopes. Such variability may cause variations in polarization with time. In this paper we report BVRI polarization measurements of 14 selected young stars. The observations were made during 1989 to 1992. Observations were discontinued due to the demise of co-investigator Dr. S.K. Jain, after a prolonged illness. The observations reported here will be useful for future observers, as these stars show photometric and polarimetric variations with time. The BVRI polarization measurements are given in Table 1 along with the distances from Gaia DR2 data.

2. OBSERVATIONS

Polarization measurements were made with a star and sky chopping polarimeter by (Jain & Srinivasulu 1991) coupled at the f/13 Cassegrain focus of the 1 – meter telescope at the Vainu Bappu Observatory (VBO), Kavalur, Indian Institute of Astrophysics. The details of the instrument and the method of data reduction have been described by Jain & Srinivasulu (1991). A dry ice – cooled EMI 9658 –R (extended S-20) photomultiplier tube and Fernie (1974) combination of UBVR broadband glass filters were used. The measured percentage of polarization (p) and position angle (θ) along with the dates of observations are given in Table 1. The observed polarization values given in Table 1 are not corrected for interstellar polarization. Since the program stars are relatively nearby, the interstellar polarization in the direction of these stars will be very low or negligible. The interstellar polarization follows a Serkowski law, which is a smooth varying function of wavelength with a small slope in the optical (Wilking et al. 1980) and is constant with time. We used the same instrument earlier and made polarization observations of a LBV star HR Car (Parthasarathy et al. 2000) and several post-AGB stars (Parthasarathy et al. 2005).

3. DISCUSSION

All the 14 stars listed in Table 1 are IRAS sources. A very small percentage of young stars have IRAS colors similar to post – AGB stars and planetary nebulae. Based on IRAS colors and far – IR flux distribution Pottasch & Parthasarathy (1988) and Parthasarathy (1993) classified SAO 112630, HD 142527, HD 143006, HD 144432 and HD 145718 as possible Post – AGB candidates. Detailed multi-wavelength studies of these stars by several investigators have established that these are indeed very young stars. Harrington & Kuhn (2009) and Alecian et al. (2013) made spectro-polarimetric observations of a large sample of Herbig Ae/Be stars which includes some of the stars given in Table 1 of this

* deceased on November 17, 1994

39 paper. These studies show variations in polarization with time and asymmetric circumstellar disks/envelopes around
40 these stars. The evolutionary status of HD 62623 is not well understood. It may be a massive star with a massive
41 circumstellar disk and gaseous envelope. We made UBVRI polarization measurements of HD 62623. BVRI polarization
42 measurements of this star are given in Table 1. The U band polarization and position angle are 1.18 ± 0.04 and
43 $88.5^\circ \pm 0.90$ (January 26th, 1990) and 1.27 ± 0.60 and $98.40^\circ \pm 1.30$ (March, 19th, 1990).

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4. CONCLUSIONS

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BVRI polarization measurements of 14 young stars are presented. All the stars have asymmetric circumstellar dusty
disks/envelopes. Several of them have protoplanetary disks with low mass binary companion stars. Most of them are
nearby stars with accurate distances based on the Gaia DR2 data. Further polarimetric monitoring of these stars is
important.

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MP thanks Dr Maheswar Gopinathan and Dr S Muneer for their help with the LaTeX file.

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Table 1. Polarization measurements of selected young stars

IRAS	HD Name	b	Sp. Type	V (mag)	P_B (%)	θ_B (°)	P_V (%)	θ_V (°)	P_R (%)	θ_R (°)	P_I (%)	θ_I (°)	Dist (pc)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
05170+0535	34700	-17.5	G0IVe	9.15	-	-	0.25±0.05						357±6
06259-1301	45677	-11.0	B2IV/V[e]	8.50	0.56±0.06	0±3.0	0.64±0.01	21.1±2.7	0.77±0.04	35.06±1.30	2.06±0.15	34.10±2.10	623±22
07236-1404	58647	1.0	B9IV	6.85	-	-	0.29±0.02	119.1±2.7					318±4
07418-2850	62623	-2.5	A4Iabe	3.93	1.17±0.20	93.6±0.20	0.91±0.03	89.10±1.10	0.88±0.04	90.50±1.40	1.52±0.63	92.70±0.60	
	-	-	-	-	1.26±0.04	98.30±0.90	1.06±0.05	92.10±1.40	1.31±0.06	88.40±1.20	1.60±0.05	97.8±0.80	
10028-5825	87643	-2.5	B3I[e]	9.50	-	-	1.21±0.09	139.40±2.00					
	-	-	-	-	0.13±0.19	144.7±42.60	1.79±0.17	140.90±2.70	0.61±0.80	126.10±3.60	0.81±0.10	127.20±3.70	
1307-5402	100453	6.8	A9Ve	7.79	0.21±0.16	119.0±22.20	0.27±0.09	167.0±9.40	0.56±0.08	122.60±4.30	0.20±0.15	105.80±22.10	104±0.5
15373-4220	139614	10.2	A9VekA5m	8.24	0.42±0.20	6.10±13.90	0.10±0.12	7.30±34.40	0.38±0.11	4.30±8.50	0.43±0.22	100.90±14.60	135±1
	-	-	-	-	0.15±0.25	153.00±46.00	0.22±0.16	149.00±21.00	0.14±0.09	107.00±19.00			
15473-0346	141569	36.9	A2VekB9m	7.12	0.53±0.04	90.20±2.20	0.76±0.02	86.30±0.90	0.91±0.03	88.70±1.00	0.77±0.06	95.60±2.20	111±0.5
	-	-	-	-	0.69±0.10	86.30±4.00	0.63±0.06	87.60±2.80	0.69±0.05	93.50±1.90	1.17±0.11	103±3	
15537-2153	142666	23.5	F0V_sh	8.82	1.39±0.27	83.70±5.60	1.10±0.13	79.80±3.50	0.79±0.11	84.40±4.10	0.89±0.22	104.20±7.10	148 ±1
	-	-	-	-	0.35±0.27	91.00±22.00	0.72±0.14	82.00±6.00	0.59±0.08	86.00±4.00	0.21±0.22	91±31	
15532-4210	142527	8.5	F6III	8.34	1.04±0.10	31.20±2.70	0.83±0.06	49.4±1.90	1.01±0.04	50.70±1.20	1.02±0.07	50.80±2.00	157±1
15556-2248	143006	22.5	G5IVe	10.14	-	-	0.47±0.09	7.80±5.30					
	-	-	-	-	0.72±0.73	3.40±29.40	0.51±0.25	153.90±14.30	0.25±0.16	162.70±17.40	0.46±0.37	177.40±22.80	166±4
	-	-	-	-	-	-	0.36±0.19	165.30±15.50					
16038-2735	144432	17.8	A9/F0V	8.19	0.17±0.14	41.30±23.00	0.21±0.06	178.00±8.00	0.57±0.04	4.00±1.90	0.25±0.10	148±11	
	-	-	-	-	0.44±0.13	156.80±8.70	0.26±0.07	163.00±7.90	0.38±0.07	153.20±5.60	0.88±0.18	177.90 1+5.70	155±1
	-	-	-	-	0.44±0.15	12.60±9.90	0.49±0.09	44.00±5.20	0.34±0.08	167.80±6.50	0.54±0.17	7.30±9.10	
16102-2221	145718	20.4	A5Ve	8.86	1.01±0.21	161.20±5.90	0.09±0.11	141.40±33.00	0.42±0.09	136.30±6.10	0.23±0.20	76.20±24.40	153±2
19089+1542	179218	2.9	A0Ve	7.39	0.37±0.08	125.10±6.40	0.74±0.06	99.70±2.40	0.58±0.06	109.80±3.00	0.57±0.13	148.90±6.40	266±3