NO. 87 WAVELENGTH DEPENDENCE OF POLARIZATION. V. POSITION ANGLES OF INTERSTELLAR POLARIZATION*

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ABSTRACT

Observations were made of the plane interstellar polarization on 22 stars. Ten of the stars show appreciable wavelength dependence of the position angles; these stars are, generally, at distances greater than 0.6 kpc. Apparently, the light traverses individual clouds that have various particle sizes as well as various orientations of the galactic magnetic field. Variations are also noted in the wavelength dependence of the amount of interstellar polarization.

THE observations were made mostly with the McDonald 82-in. reflector in November 1963 and January 1964. Additional measurements were made at the McDonald 36-in., the Kitt Peak 36-in., the Lowell 21-in. (by S. F. Pellicori), and the Catalina 21-in. (by D. L. Coffeen). The polarimeter and procedures are the same as used before (Gehrels and Teska 1960). Starting with the January 1964 run, the output of the integrators is digitized and punched on paper tape. The program for handling the data at the IBM 7072, of the Numerical Analysis Laboratory at the University of Arizona, was written by Mrs. Tricia Coffeen.

Table I gives the percentage polarization. The stars are in order of galactic longitude, and are identified by the number in the Henry Draper catalogue, the filters by $1/\lambda$ in reciprocals of microns. The probable error of a single observation, determined from repetition, is $\pm 0.07\%$. Colons are used when the probable error of the listed value appears to be greater than $\pm 0.2\%$, or (in Table III) $\pm 3°$. The usual, small, corrections for instrumental polarization (viz., Paper I) are applied at an early stage in the reductions. The depolarization correction factor, determined during the observing run, is 1.01; all polarizations were multiplied by 1.01 before entry in Table I. A few of the stars had already been observed (Paper II); with the present data the weighted means are updated. Similarly, some of the stars will reappear in later papers. When only a single observation is available, a semicolon is used in the tables.

Table II gives a few observations made with the *G* filter/tube combination (Table I of Gehrels and Teska 1960); θ is the position angle in the equatorial reference frame.

Table III lists the observations of position angle θ.

TABLE I. Observed percentage of interstellar polarization.

HD	Percentage polarization observed at $1/\lambda =$ 1.05	1.19	1.39	1.95	2.33	2.79	3.04
147165	1.12;	1.36;	1.37;	1.68;	1.53;	1.39;	1.35
134335	0.39	0.61	0.58:	0.58	0.78	1.10	0.68
134320	0.69:	0.47	0.49	0.71	0.65:	0.57:	···
207260	1.05;	1.24;	1.30;	1.47;	1.57;	1.49;	1.18;
217476	2.01;	2.23;	2.58;	2.64	2.53;	2.49	2.85:
224014	1.01	1.13	1.32	1.37;	1.18;	1.06;	1.13:
2905	1.14	1.10	1.37	1.41;	1.34;	1.20;	1.19;
7927	2.30	2.47	2.99	3.32;	3.34;	2.89	2.92
12301	2.01	2.37	2.41	2.80	2.72	2.58	2.14
12953	1.96	2.70	2.96	3.48	3.40	3.25	2.94
14489	1.43	1.55	1.80	2.10	2.03	2.01	1.87:
21291	2.37	2.77;	3.13;	···	3.30;	3.02:	2.79;
21389	2.47	2.75	3.18	3.75;	3.61;	3.39	3.15
30614	0.89:	1.13	1.44	1.90;	1.87;	1.74;	1.83;
25291	1.49;	1.59;	1.64;	2.27;	2.12;	2.13	2.00
24398	0.93	1.02	1.16	1.07;	1.02;	0.75;	0.76;
31964	1.45;	1.62;	1.78;	2.09;	2.16;	1.97;	1.97;
36371	1.52;	1.70;	2.04;	2.23;	2.09;	1.83	1.78
37202	1.40;	1.26;	1.21;	1.46	1.53	0.98	0.68
41117	1.95	2.27;	2.50;	2.92	2.81	2.42	2.47
42379	1.88	2.07;	2.63;	3.10	2.81;	2.98	2.44;
37041	0.91	0.94	0.91	0.87	0.58	0.39	0.33

A colon is given for poorer data, and a semicolon is for single observations.

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TABLE II. Additional observations of interstellar polarization, made with a filter at $1/\lambda = 1.85$.

HD	$P\%$	θ
224014	1.51;	···
21291	3.40	114°.7
21389	3.50;	120.7;
24398	1.33;	59.9;
41117	2.81;	175.0;
42379	2.73;	174.0;

TABLE III. Observed position angles of interstellar polarization.

HD	Position angles observed at $1/\lambda =$ 1.05	1.19	1.39	1.95	2.33	2.79	3.04
147165	177.7;	174.3;	175.9;	175.9;	178.7;	177.8;	179.9
134335	64.0:	82.0:	62.8:	76.3:	72.6	···	···
134320	64.4:	75.6:	82.0:	75.3	77.7	···	···
207260	44.1;	37.2;	46.0;	39.7;	41.1;	39.3;	46.6;
217476	69.4;	69.5;	68.7;	70.5	70.1;	74.8:	70.0
224014	51.7:	52.3	53.8	51.1;	52.5;	···	···
2905	79.3	80.8	80.2:	83.6;	86.0;	88.3;	92.0;
7927	90.5	91.4	90.8	94.6;	94.8;	94.6	97.8
12301	108.1	109.1	109.6	112.2	112.2	113.0	114.6
12953	103.5	107.5	107.0	110.1	110.8	112.2	112.9
14489	107.3	112.2	110.5	113.8	115.0	116.1	121.1
21291	117.0	115.8	116.4;	···	113.0;	115.1;	117.0;
21389	118.9	119.4	119.6	121.3;	122.0;	121.9	122.3
30614	133.4	136.0	136.9	139.5;	140.1;	140.0;	139.4;
25291	133.3;	132.8;	132.3;	133.4;	132.9;	131.0	134.3
24398	60.7	56.7	60.1	60.3;	60.1;	58.5;	63.6;
31964	143.9;	145.8;	144.4;	143.8;	143.2;	144.7;	146.4
36371	177.6;	176.5;	178.6;	173.5;	172.2;	170.6	168.9
37202	30.4;	31.0;	33.7;	26.0	27.5	23.3	17.6
41117	179.9	177.8;	179.9;	173.2	172.8	174.6:	172.6:
42379	170.0	172.7;	181.0;	164.1:	168.0;	169.9	168.1;
37041	96.7:	104.5:	89.6:	105.6	100.4:	96.6:	···

TABLE IV. Residuals of position angles.

HD	Observed minus average for each star, at $1/\lambda=$ 1.05	1.19	1.39	1.95	2.33	2.79	3.04	Galactic long.	Galactic lat.	Dist.[a]
147165	+1°	− 3°	− 1°	−1°	+2°	+1°	+ 3°	319°	+16°	n
134335	−9	+11	− 9	+5	+1	···	···	4	+58	n
134320	−9	+ 1	+ 7	0	+3	···	···	6	+58	n
207260	+2	− 5	+ 4	−4	−1	−3	+ 5	70	+ 6	n?
217476	−1	− 1	− 2	0	0	+5	0	76	− 3	f
224014	−1	0	+ 2	−1	0	···	···	83	− 4	n?
2905!	−5	− 4	− 4	−1	+2	+4	+ 8	89	0	f?
7927!	−3	− 2	− 3	+1	+1	+1	+ 4	95	− 4	f
12301!	−3	− 2	− 2	+1	+1	+2	+ 3	98	+ 3	
12953!	−7	− 2	− 2	+1	+2	+3	+ 4	101	− 2	f
14489!	−6	− 2	− 3	0	+1	+2	+ 7	103	− 4	f
21291	+1	0	+ 1	···	−3	−1	+ 1	109	+ 4	f
21389!	−2	− 1	− 1	+1	+1	+1	+ 2	110	+ 3	f?
30614!	−5	− 2	− 1	+2	+2	+2	+ 2	111	+15	f?
25291	0	0	− 1	+1	0	−2	+ 1	113	+ 6	n
24398	+1	− 3	0	0	0	−2	+ 4	130	−16	n
31964	−1	+ 1	0	−1	−1	0	+ 2	131	+ 2	n
36371!	+4	+ 3	+ 5	−1	−2	−3	− 5	144	+ 1	f?
37202!	+3	+ 4	+ 7	−1	0	−4	−10	153	− 4	n?
41117!	+4	+ 2	+ 4	−3	−3	−1	− 3	157	+ 3	
42379	−1	+ 2	+10	−7	−3	−1	− 3	157	+ 3	f
37041	−2	+ 6	− 9	+7	+2	−2	···	177	−18	f?

[a] In the distance column, *near* stands for 0.1–0.6 kpc and *far* for 0.8–2.1 kpc. The stars with exclamation marks (!) show appreciable wavelength dependence of the position angles.

The method of calibration is described by Gehrels and Teska (1960).

Table IV shows the wavelength dependence of the position angles. For each star the straight average is determined, and the difference between observed and average value is given in Table IV. Also listed are the galactic longitude and latitude (Lund Pole), and an approximate distance indication.

It is seen in Table IV that the nearby stars generally have no wavelength dependence of the position angles. Some of the farther stars show a certain trend at longitudes 89–111° (Cassiopeia), and a reversed trend is seen at 144–157° (Taurus).

An interpretation, and in fact a prediction, of the wavelength dependence of position angles had already been made by Treanor (1963): "If the existence of a color dependence of polarization on particle size is accepted, physical situations will undoubtedly arise in which this will entail also a color-orientation dependence. The most easily envisaged case is one in which starlight passes through two successive clouds with different orientation of the dust particles relative to the line of sight, and different mean projected particle size." On this interpretation, we may expect interesting detail and sharp reversal of the $\theta-\lambda$ trends when individual clouds are traversed.

Certain variations in the wavelength dependence of the percentage polarization are also noted (Table I). Many stars show the characteristic curve (shown in Paper II), with "a maximum at 6500 Å, decreasing sharply toward longer and gradually toward shorter wavelengths." The interpretation is that the particles have diameters near 0.3 μ and refractive index of that of dirty ices. The characteristic curve is shown by HD 147165 in Table I. HD 37041, however, has a steep rise from the ultraviolet to infrared, showing the presence of larger particles (same refractive index). An indication of large particles is in an excess polarization for filters $1/\lambda=1.05$ and 1.19 (example HD 37202 in Table I). An indication of smaller particles is in an excess in the ultraviolet, for example HD 30614.

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