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NEW VARIABLE STARS IN THE FIELD OF M 16 - M 17

Eight years ago the writer noticed the marked increase of the number of Mira type variables when a field of stars is observed in infrared radiation (Maffei, 1967). At that time he also observed some differences in the behaviour of a few variable stars of different type when blue-infrared comparison was made.

This finding was based on the photographs of stars fields just a few square degrees wide, and the Mira stars involved were only fifteen.

In order to begin again the research on a statistical ground the writer started a systematic photographic search and observation of variable stars, in blue and infrared radiation, in 5 fields of some 25 square degrees each, at different galactic longitudes. The collection of the plates was effected with the two Schmidt telescopes of the Osservatorio Astrofisico of Asiago (mainly with the 90/65 cm telescope) beginning from the summer of 1967. 103a-O (without filter) and I-N (hypers.) + RG5 were used.

The examination of the first of these fields, centred on $\alpha=18^h14^m$, $\delta=-14^o50'$ (1900.0), containing the objects M 16 and M 17, has led to the discovery of 198 new variable stars, almost all visible on the infrared plates only. The plates were compared by means of the blink microscope of the Asiago Observatory. This operation was based on four pairs selected from 50 plates. A comparable number of plates obtained in blue light yields only 2 new variables.

The main characteristics of the 198 variables are listed in Table I. The variables have been arranged in order of discovery. This numeration, characterized by the prefix M, will be continued in the remaining fields. The lack of some numbers is due to the exclusion of a few variables, not confirmed during the investigation following the discovery. The identification charts, light curves and a detailed account will be published, in a short time, in a more extensive work.

Table I

Var. N.	A.R. (1950.0)	Dec.	m_{ir}		Type	P	E 24.....
M 1	$18^h 7^m 14^s$	-15°14'38"	11.7	15.4	M	193^d	40814
M 2	6 48	14 56 13	14.8	16.2	M or SR	320::	
M 3	6 1	14 9 4	13.2	15.7	M	237	41110
M 4	8 8	14 26 43	13.8	16.1	SR:	390:	40404
M 5	8 10	14 23 50	15.6	16.5			
M 6	12 8	15 49 17	15.4	16.2	SR:	350::	
M 7	14 9	15 19 27	11.2	15.7	M	280	41198
M 8	9 26	14 25 26	12.4	16.0	M	460	41048:
M 9	16 17	14 48 59	13.1	16.1	M	486:	40072:
M 10	22 30	15 33 43	13.1	16.2	M	417	39758
M 12	13 1	19 39 48	11.2	15.1	M	334	41260:
M 13	13 29	12 46 42	14.7	16.1	M or SR	288:	40810
M 14	17 14	12 45 21	13.9	16.2	M or SR		
M 15	26 31	15 9 59	14.3	16.2	M	362	39746
M 16	10 41	16 14 44	8.4	11.0	M	279	40784
M 17	8 52	15 9 41	11.7	15.9	M	510	40520:
M 18	11 32	15 32 0	12.0	15.8	M	394	41220
M 19	7 6	14 21 21	14.5	16.2	M or SR		
M 20	6 38	14 8 25	14.2	16.1	SR::	375::	41246::
M 21	11 16	15 7 27	14.8	16.2			
M 22	12 12	14 8 48	13.0	16.0	M:	400:	41040:
M 23	24 30	16 17 32	14.2	16.9	SR::	366::	39680::
M 24	27 6	15 20 43	14.0	15.8			
M 25	12 38	12 58 32	14.3	16.1	M	247	41143
M 26	24 23	15 51 28	13.5	17.1	M	444	41118
M 27	18 37	13 13 19	15.4	16.4	L:		
M 28	18 48	12 44 24	14.7	16.3			
M 29	14 40	17 43 26	13.3	16.0	M::	450::	39748
M 30	5 30	15 24 32	14.0	15.9	SR	270:	41164
M 31	5 43	15 8 8	13.7	16.0	RV::		
M 32	5 48	15 10 8	13.9	16.2	M	270	41178
M 33	7 32	15 23 2	13.2	15.9	M	338:	
M 34	8 10	15 36 37	12.8	15.9	M	202	41096
M 35	15 35	17 26 51	15.5	16.2			
M 36	15 54	17 45 7	12.3	15.6	M or SR	396::	
M 37	16 33	17 49 6	12.3	15.8	SR::	135::	41138:
M 38	9 33	15 46 10	12.9	15.9	M	336	40806
M 39	9 25	15 48 11	12.3	15.3	M	204	40804
M 40	9 5	15 40 12	13.0	16.2	M	531	41128
M 41	9 28	15 23 29	13.8	16.4	SR::		
M 42	7 37	15 8 35	13.6	16.4	M	482	41226
M 43	7 14	14 49 58	12.6	15.7	M	478	40816
M 45	9 15	14 55 37	12.6	16.2	M	285	40762:
M 46	11 6	15 22 54	14.2	16.0			
M 47	18 48	17 33 33	12.3	15.0	M	208	41144
M 48	18 28	16 44 23	12.0	15.6	M		
M 49	9 17	14 45 33	14.6	16.5	M	210:	40840:
M 50	7 47	13 52 1	11.8	15.6	M	434	40032
M 51	11 50	15 4 51	14.8	16.2			
M 52	21 15	17 5 18	14.1	15.8	M or SR	390::	
M 53	21 31	17 5 36	13.8	16.3			
M 54	21 45	17 6 45	12.8	15.8	M::	290::	
M 55	13 54	15 10 39	11.4	13.6	SR:	490:	40836:

Table I (cont.)

Var. N.	A.R. (1950.0)	Dec.	m_{ir}		Type	P	E 24.....
	$18^h12^m11^s$	-14°34'39"				d	
M 56			13.0	15.5	SR	210?:	
M 57	22 16	16 38 7	11.6	15.2	M:	442::	41214
M 58	23 55	16 23 34	14.7	17.2	M:	298	41100
M 59	24 48	16 23 50	13.8	17.6	M	405:	41152:
M 60	24 54	16 9 2	11.2	15.4	M	312:	41162
M 61	23 44	15 52 30	14.2	17.3	M	290	39745
M 62	12 31	13 9 51	12.8	16.2	M::	500:	41066::
M 63	24 23	15 34 19	14.0	16.4	M	384:	40754
M 64	25 14	15 56 45	13.5	17.0	UG or RW		
M 65	26 20	15 39 41	15.6	17.2	M	250::	41238::
M 66	25 27	15 27 47	12.9	15.9	M	313	40055
M 67	25 50	15 24 52	12.6	15.3	M	298	40458
M 68	25 39	15 21 22	13.7	16.4	M	315	39740:
M 69	23 17	14 49 5	12.1	14.7	SRc		
M 70	13 31	12 45 6	14.9	16.1	L:		
M 71	22 9	14 19 56	12.2	15.9	M::	522::	41142
M 72	24 8	14 43 41	7.6	11.6	M	400	39758
M 73	25 5	14 50 35	12.5	16.8	M	322	40478:
M 74	25 29	15 7 58	12.8	16.4	M	310	40082
M 75	25 44	14 58 17	13.2	16.0	M	319:	39749
M 76	27 59	15 39 37	12.8	16.2	M:		41164
M 77	28 44	15 29 8	10.0	15.5	M	468	41158
M 78	28 33	15 20 31	12.1	15.6	M	428::	40137::
M 79	26 10	14 45 52	12.0	15.4	M	312	39720
M 80	26 3	14 31 20	12.1	15.4	M	477	40804
M 81	17 10	12 37 35	12.4	15.9	M	310	40826
M 82	17 48	12 9 59	13.8	15.8	M:	304	39730
M 83	21 23	13 17 35	14.5	16.0	L:		
M 84	27 23	14 27 22	11.4	15.0	M	302	41100
M 85	27 53	14 54 53	11.3	14.1	M	264	41170
M 86	13 52	16 53 20	12.6	15.5	SR::	365:	
M 87	24 60	13 45 3	12.9	13.9	L:		
M 88	14 39	17 33 13	14.9	16.0	SR:		39744
M 89	8 13	16 13 40	13.4	15.2	M or SR	360::	
M 90	5 34	15 35 37	11.2	16.0	M	256	40860
M 91	5 38	15 34 20	15.4	16.3			
M 92	5 44	15 4 30	12.0	14.0	R CB:		
M 93	8 31	15 38 12	14.4	16.3	SR or M	210	41222
M 94	8 41	15 45 1	14.2	16.7	SR:	320::	
M 95	9 2	15 40 58	13.1	16.0	M	396	40790
M 96	16 33	17 47 6	13.8	15.8	M::	400::	39750::
M 97	17 2	17 44 28	12.9	15.4	M::	450::	40424::
M 98	8 57	15 38 5	13.4	16.4	M	465:	40928::
M 99	17 24	14 52 9	14.0	16.1			
M100	6 27	14 38 44	14.5	16.6	M or SR		
M101	5 21	14 34 49	10.9	15.9	M	358	41244
M102	5 3	14 31 52	14.0	16.4	M::	360::	40860::
M103	5 35	14 18 37	14.3	16.4	M or SR	400::	41136
M104	6 44	14 27 14	14.5	16.0	SR		
M105	7 8	14 51 52	12.2	15.4	M	316	40410
M106	8 48	14 47 49	11.7	15.4	M	434	41092
M107	9 42	15 21 46	14.5	16.2	SR:		
M108	18 14	17 7 46	13.7	16.3	M or SR		

Table I (cont.)

Var. N.	A.R. (1950.0)	Dec.	m_{ir}		Type	P	E 24.....
M 109	$18^h20^m12^s$	-17°22'43"	13.3	14.8	M or SR		
M 110	14 5	15 54 30	13.1	16.2	M::	365::	41224
M 111	19 6	16 35 35	14.8	16.4			
M 112	21 24	17 9 0	13.3	15.8	M or SR	390::	41144::
M 113	22 11	17 5 42	14.6	16.0			
M 114	14 45	15 3 35	11.2	12.1	E		
M 116	8 27	13 36 22	14.3	16.4	M or SR		
M 117	11 56	14 9 7	11.6	14.7	M	213	40808
M 118	18 31	15 43 10	14.5	16.1	M or SR		
M 119	21 34	16 11 47	13.8	17.2	M	608	39734
M 120	22 46	16 35 33	11.2	15.3	M	379	41247
M 121	16 45	14 40 48	11.6	12.7	M:	226:	41124
M 122	15 49	14 46 2	12.0	15.1	M:	388	41100
M 123	23 54	15 59 23	14.7	17.2	M	374	37556
M 124	24 59	16 24 3	14.4	17.4	M	410::	40432::
M 125	25 2	16 23 30	16.1	17.4			
M 126	25 26	16 23 9	13.2	16.6	M:	510::	41092:
M 127	25 45	16 5 25	15.0	16.9	M or SR		41186
M 128	24 2	15 42 17	14.1	17.4	SR:	227::	39722
M 129	13 58	13 15 45	11.7	16.2	M	450	40844
M 131	12 38	12 51 21	13.9	16.2	M or SR		
M 132	13 44	12 43 22	14.8	16.6			
M 134	26 31	15 49 31	11.5	15.4	M	450	39712
M 135	26 40	15 50 43	11.7	15.2	M	716	40394
M 136	27 10	15 30 35	15.0	17.0	M or SR		
M 137	27 22	15 29 29	14.6	17.2	SR::		
M 138	22 49	14 44 49	12.7	15.3	SR	400::	39684::
M 139	17 28	13 10 38	14.3	16.0		380::	
M 140	17 11	13 11 0	12.9	16.0	M	506	40448
M 141	15 25	12 11 35	12.0	15.8	M	407	41058
M 142	15 26	12 28 18	12.3	15.8	M	420	41220:
M 143	16 34	12 25 7	12.1	15.8	M	410	40424
M 144	16 49	12 35 47	13.6	15.9	SRc:		
M 145	25 42	14 58 31	13.9	16.0	M	366	41164
M 146	25 26	14 14 20	11.3	15.2	M	378	41098
M 147	20 27	13 3 12	14.4	16.4	SR:	486::	40020::
M 148	17 56	12 30 5	13.9	15.8	M	259:	40798:
M 149	21 34	12 53 49	10.4	15.4	M:	600:	40388::
M 150	25 21	13 46 30	14.4	15.8			
M 151	26 50	14 2 21	12.2	15.6	M	468	41104
M 152	27 8	14 12 16	13.5	16.1	M	416::	41064::
M 153	27 46	14 18 28	14.0	15.6	M	354:	41214:
M 154	27 38	14 23 41	12.9	15.4	M	405	41120:
M 156	9 28	15 5 50	11.6	12.7	EA		
M 159	18 54	13 2 10	14.1	15.5	EA		
M 161	14 24	17 35 16	15.3	15.9			
M 162	8 20	16 4 9	14.7	16.5	SR::		
M 163	6 17	15 51 53	13.2	16.4	M	288	41238
M 164	6 32	15 20 7	10.1	13.4	M	239	41214
M 165	6 14	15 19 8	13.0	15.7			
M 166	7 32	15 32 39	15.2	16.4			
M 167	8 20	15 46 5	14.8	16.3	SR::	330::	
M 168	16 39	17 49 57	12.4	15.6	M	286:	39720

Table I (cont.)

Var. N.	A.R. (1950.0)	Dec.	m_{ir}		Type	P	E 24.....
M 169	$18^h17^m\ 4^s$	$-17^o32'54"$	14.7	16.0	L:		
M 170	15 59	17 19 45	14.1	16.0			
M 172	5 45	14 48 5	14.5	16.7			
M 173	5 11	14 44 38	14.0	16.3	M or SR		
M 174	6 23	14 30 20	15.0	16.2			
M 175	13 51	15 52 13	13.8	15.0			
M 176	10 2	14 47 4	14.2	16.0	M or SR	200::	41190:
M 177	7 37	14 26 43	13.1	16.3		218	39720
M 178	13 15	14 59 54	14.4	16.5	SR:	280::	
M 179	12 46	15 6 35	15.1	16.4	M:	298::	39738
M 180	13 10	15 19 6	12.5	15.9	M	458	41104
M 181	12 34	14 3 7	14.5	16.4	M or SR		
M 182	14 51	14 36 8	13.7	16.4	L:		
M 183	22 54	16 13 32	16.0	16.8			
M 184	22 17	16 12 19	16.2	17.2			
M 185	21 49	16 10 51	15.5	17.2	M::	268:	40800
M 186	13 56	13 42 22	15.3	16.4			
M 187	22 10	15 42 49	14.3	16.8	M:: SR::	400::	41152
M 188	23 0	15 33 55	14.4	16.7	M:	416	41240
M 189	15 9	13 6 4	13.8	16.0	M	290	41192
M 190	17 49	13 34 10	12.8	15.0	M	190	41160
M 192	25 37	15 8 25	13.8	16.8	M:	418:	40849:
M 193	25 21	15 16 34	13.6	16.4	M	478::	41164
M 194	14 47	12 40 29	13.2	15.4	M or SR	700::	
M 195	16 1	12 25 0	11.9	16.0			
M 196	16 24	12 36 13	13.6	16.0			
M 197	17 57	12 54 12	13.0	15.8	M	400	41186
M 198	26 11	14 48 56	12.5	16.1	M	335:	37558
M 199	27 2	14 59 56	14.1	15.8	M	330	39720
M 200	28 50	15 14 24	12.0	15.8	M	448::	37870:
M 201	26 48	14 48 11	14.4	16.0	M	318	41168
M 202	27 25	14 33 31	11.0	14.9	M	400	39758:
M 203	20 21	12 39 32	14.6	16.1	SR	400	
M 204	24 45	13 40 44	12.3	15.6	M	376	37570
M 205	27 24	14 23 39	12.9	15.5	M	301:	41126:
M 206	28 34	14 45 58	12.7	15.9	M:	460::	39690:
M 207	10 8	14 55 19	13.3	16.6	M	480	40756
M 208	27 6	14 44 52	12.9	14.6	SR::		

Of the 198 new variables, 108 have been classified as Mira type stars and 25 as SR. Before this research only 31 variables were known in the field. From this number we have excluded 52 variables of RWn type, found by Walker (1961) in the cluster M 16, fainter than m_{pg}= =20 and therefore below the limit magnitude of our research. Those of Mira type were 7, all discovered by the writer, with the same infrared technique.

This result confirms the very strong increase of the number of Mira type stars when the observations are made by means of infrared technique. Moreover the most frequent period of these new infrared

Miras is some 100 days longer than that of the known Mira stars, in the direction of the galactic centre. This is shown in Fig. 1, where the histogram constructed with the periods of the new Miras is compared with that obtained by Romano and Di Tullio (1970) for the Miras in the zone of the galactic centre given in GCVS.

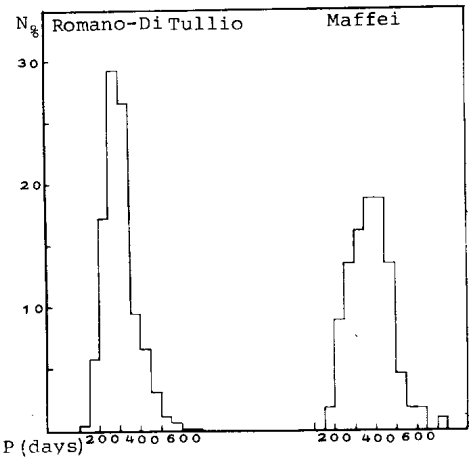

Fig.1 Number of Mira variable stars (normalized at ΣN = 100) as function of the length of the period. Left: the results of Romano and Di Tullio, for the region of the galactic centre; right: present results.

The increase of the period's length proves that the rise in number of Mira stars must be mainly due to physical effect and not only to the diminished effect of the interstellar absorption by using infrared technique. In other words, while, till now, the blue variable stars have been favoured by the photographic or photoelectric (U,B,V) techniques of observation, the study of the Mira stars can start to advance toward a reasonable completeness only at present, through these infrared observations, which favour the stars which are redder, cooler, imbedded in circumstellar envelopes, etc.

Other prospects appear from the study of the light curves in the infrared. The first result on this subject will be published in the next issue of the IBVS.

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