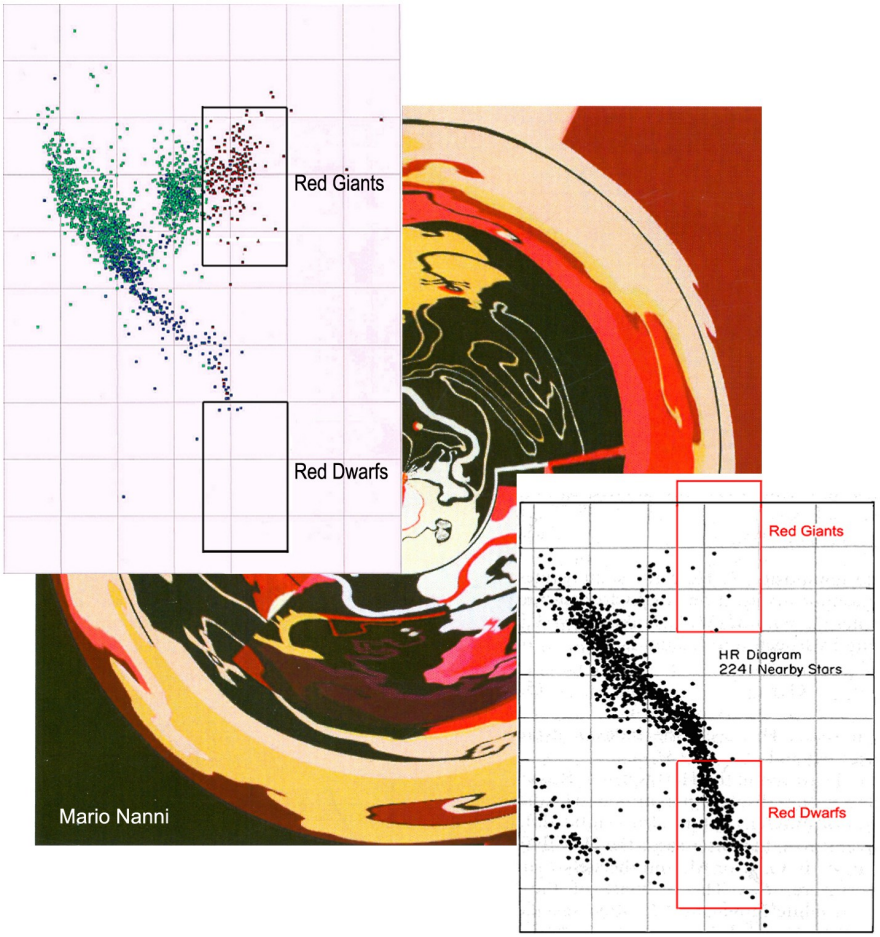
Vittorio B. Goretti

Research on Red Stars in the Hipparcos Catalogue



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PART I

REMARKS AND QUESTIONS ON THE HIPPARCOS CATALOGUE

1. Preliminary remark

Some years ago J. Kovalevsky wrote an interesting article on the scientific results of the Hipparcos Mission, which was published in "Memorie della Società Astronomica Italiana", Volume 64 - No. 1-1993, p. 28.

Here is part of Kovalevsky's original text:

« 6. ASTROMETRY

During the first year of mission, stars have been observed, in the mean, nine times. But in many cases, they were observed several times in consecutive days on almost identical RGC's so that astrometric information has not enough variety and is strongly correlated so that astrometric parameters cannot be separated. Several different sphere reconstitutions were made. The most significant results have been obtained with 19000 best observed stars keeping only positions and parallaxes as astrometric unknowns. The coordinates were determined with a precision generally comprised between 1.5 and 3 mas (fig. 4). The corrections to the positions given in the Input Catalogue present an rms of about 0".3 a number that confirms the excellent quality of this catalogue. The results for the parallaxes present similar standard errors (fig. 5). The number of negative parallaxes is consistent with the distribution of errors, having in mind that most of the stars of the observing program are quite distant, generally more than 200 parsecs away. To the level of precision of Earth-based parallax determinations, it appears that there is no visible bias between them and the HIPPARCOS results (fig.6). However, evidently the precision of the latter are much better. Let us also note that comparisons made with similar results obtained by NDAC show an excellent statistical agreement with our results. »

There was a particularly striking fact emerging from the observation work carried out by the satellite regarding the distribution of stars around the Sun, especially concerning their distance, which measures for the majority of them more than 200 parsecs.

It is interesting to point out that based on "stellar statistics" in astrophysics, the stars of the main sequence, the "Dwarfs", are predicated to be much more numerous than the "Giants" and "Supergiants".

The "Dwarfs" number about 50 billion, while the "Giants" are about one million, with an approximate ratio of 50,000 to 1. That ratio is noticeably lowered by the selection effect when observation work is done through a telescope, both from the ground and in orbit. This is caused by the fact that the Giants are visible from great distances, while the Dwarfs, due to their lower intrinsic luminosity, are less easily perceived.

All the above having been said, the purpose of this study is to find the true approximate ratio between "Dwarfs" and "Giants" among the red stars examined by the Hipparcos Mission.

2. The research

2.1 Methods

To start with, a careful choice was made of a fairly wide zone of the vault of heaven including about 2400 stars all provided with a Hipparcos Catalogue number and no other stars. This zone is comprised between 00 h and 01h Right Ascension and between 0° and +90° Declination. The zone is represented in Figure 1.

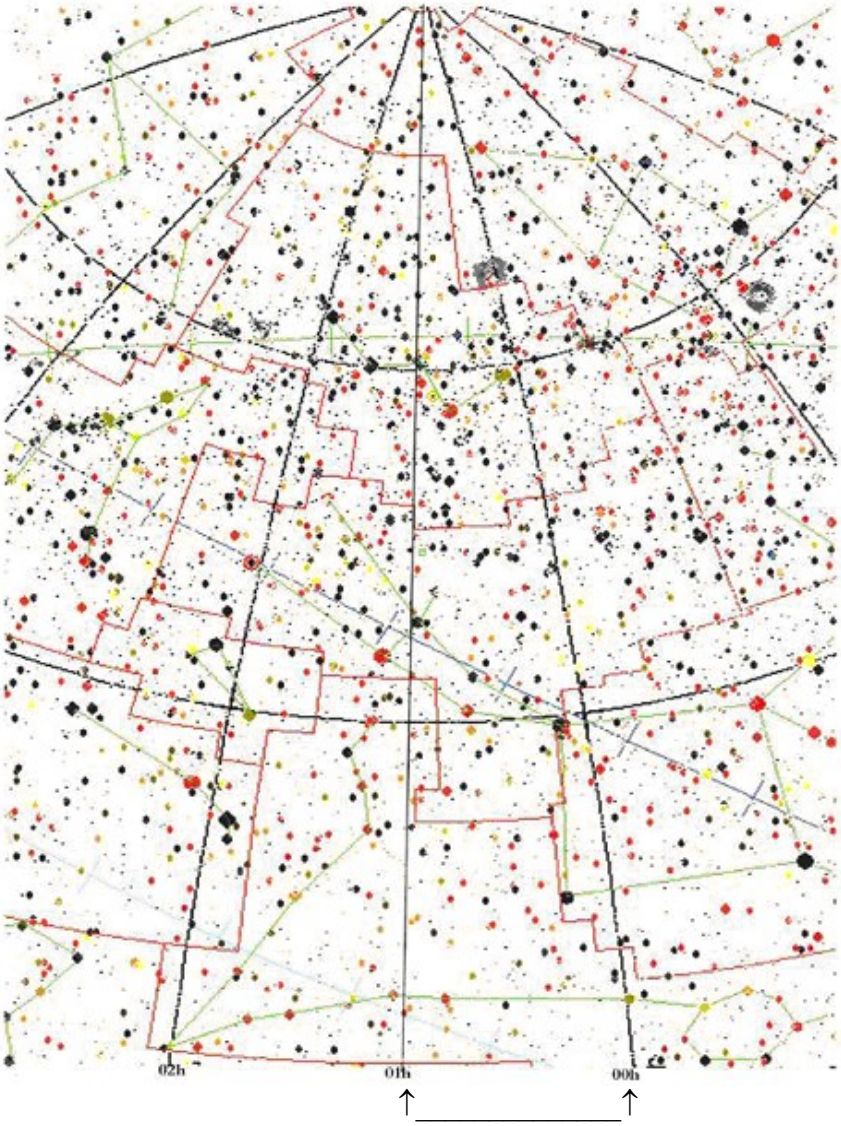

Figure 1

For each star I copied from the Hipparcos Catalogue the values of **absolute magnitude M** and of **colour index B-V** (Johnson). I used all those data to draw a Hertzsprung-Russell diagram taking the precaution of employing different colours to show the different typologies of stars:
Blue for the stars with large proper motion, therefore already well known and studied for a long time (before the Hipparcos Mission);
Red for red stars (those with a B-V colour index > 1.25); **Green** for the rest.
Figure 2 shows the diagram thus obtained.

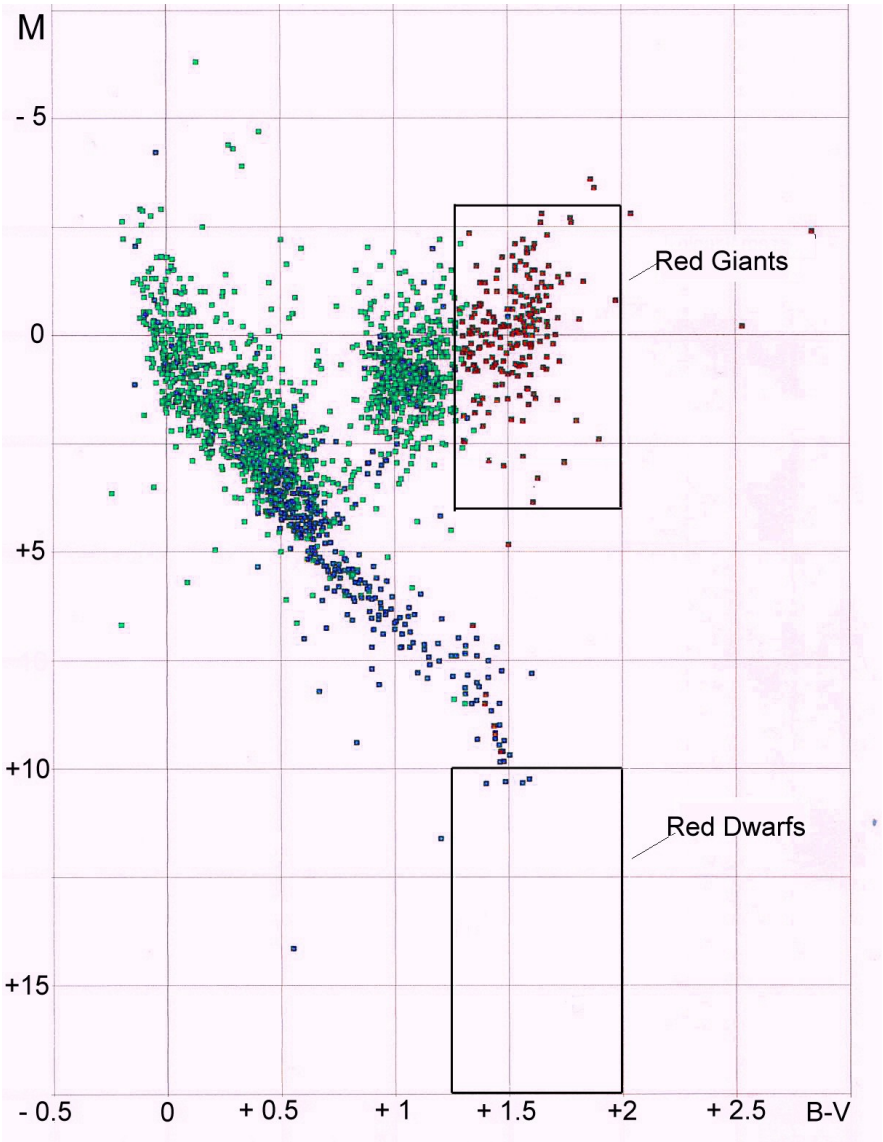

Figure 2

In the following Figure 3 the same diagram was repeated drawing only the **blue** and the **red** stars. The stars with large proper motion (the blue ones) plot the main sequence, while the other stars (the red ones) analyzed by the Hipparcos Mission turn out to be nearly all “Giants”.

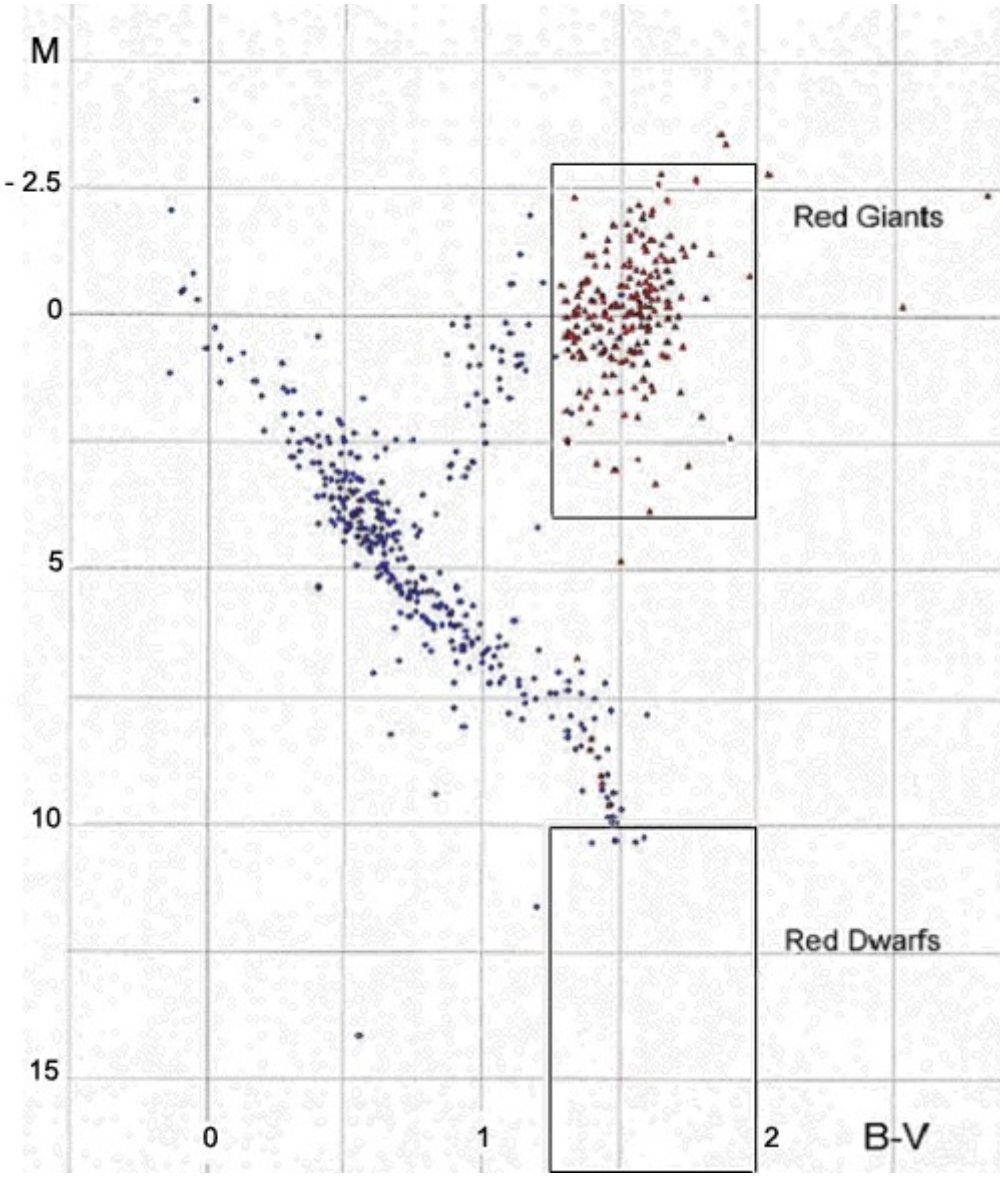

Figure 3

These diagrams (Fig. 2 and Fig. 3) offer a clear, unequivocal picture of the number and distribution of the celestial bodies in the space examined according to the Hipparcos Catalogue.

2.2 Remarks and Questions

By comparing Fig. 3 with Fig. 4, the latter showing an H-R diagram with about the same number of stars (see Kenneth R. Lang, *Astrophysical Formulae*, Volume II p.88), you can notice a clear discrepancy.

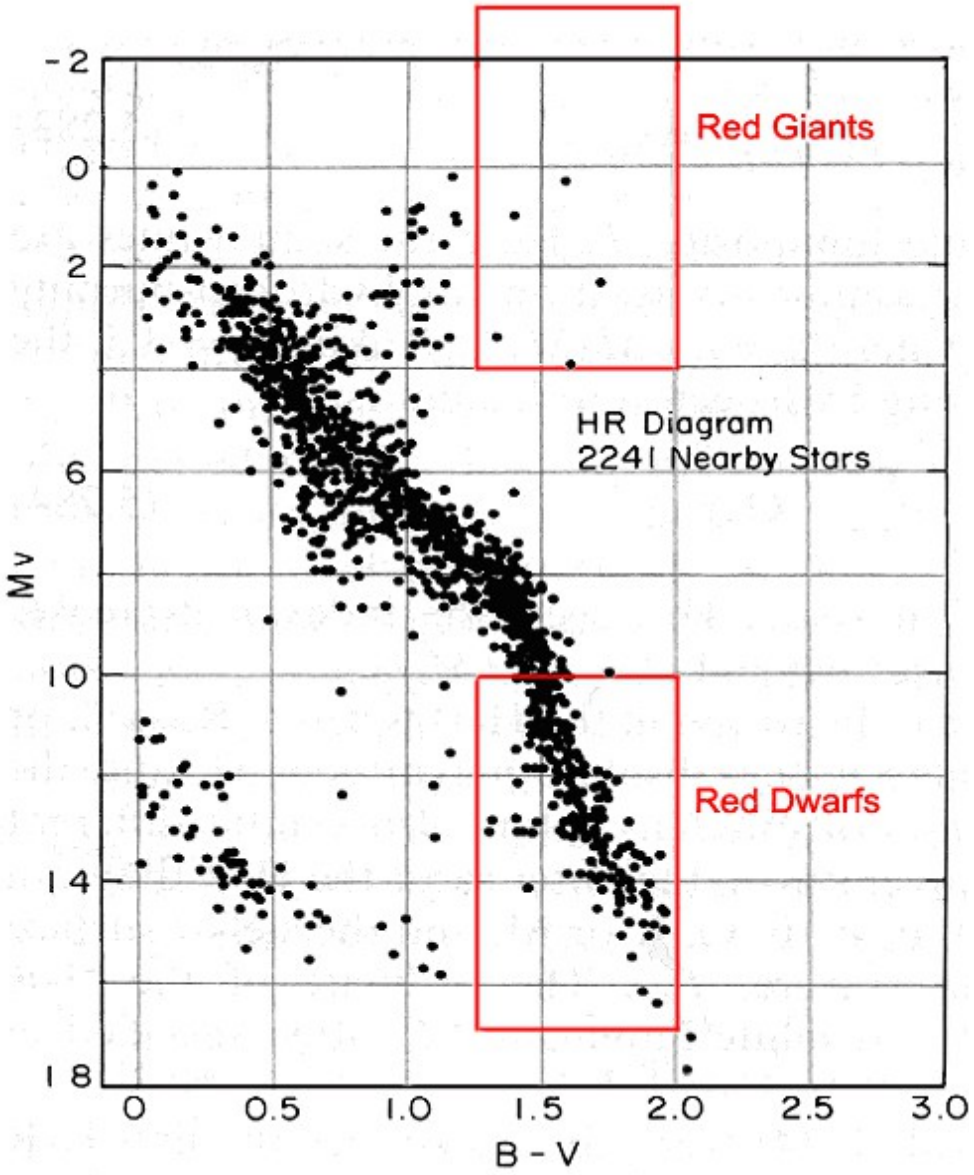

Figure 4

Some questions arise spontaneously after a first consideration of what emerges from the present investigation.

How comes that over three hundred red stars contained in the sky zone examined turn out to be all "Giants" and not even one is a "Dwarf"?

It does not seem credible that in so small a sky zone (1/48th of the heaven vault) there could be such a concentration of Red Giants.

2.3 Possible explanation

Since the Hipparcos astrometric measurements had been meticulously checked, it would be of great interest to have an explanation to the questions that instinctively arise from this discrepancy.

How can all that be explained? A clear answer is to be hoped for.

My guess is that probably the researchers' computer program did not specify that, when calculating the average of all parallax angles referring to each star, any negative values of parallax angles had to be considered only in their absolute value. As a matter of fact, about half the average values of the parallax angles in the Tycho Catalogue turn out to be negative!

Hence, it is useful to specify that:

1. The parallax angle, which is one of the angles of a triangle, is positive by definition. When we average a number of parallax angles, it is even more necessary to keep this in mind or the average value containing negative addends will almost always be low, at times positive and at times negative. This may happen even when all the absolute values of the single parallax angles of a star are much higher than the average thus calculated.

2. The closer to zero the parallax angle of a star turns out to be, the farther away that star is.

3. The Hipparcos Catalogue stars, about 118,000 stars, are a choice from the over 2,000,000 stars of the Tycho Catalogue. As regards the data concerning the same stars, the main difference between the two catalogues lies in the measurement errors, which in the Hipparcos Catalogue are smaller by about fifty times. I cannot understand how it was possible to have such small errors (i. e. uncertainties of the order of one milliarcsecond) when the typical error of a telescope with a diameter of 20 ÷25 cm is comprised between 20 and 80 milliarcseconds (see the Tycho Catalogue). When averaging many parallax angles of a star, the measurement error of the average (root-mean-square error) cannot be smaller than the average of the errors (absolute values) of the single angles.

It would be important for the Hipparcos researchers to confirm their catalogue measurements with new ones performed from the ground, especially in the case of stars whose parallaxes were not known before the 1991÷1994 Hipparcos Mission.

Regarding my research, to further support the *reductio ad absurdum* on the lack of reliability of the Hipparcos Catalogue, I provided more evidence by following the same procedure three more times. The sky zones studied were, with Dec from 0° to 90°, respectively RA from h 6 to h 7; RA from h 12 to h 13; and RA from h 18 to h 19.
The result was similar to what is shown in the previous pages.

PART II

RESEARCH CONDUCTED AT LOIANO OBSERVATORY (Bologna, Italy)

with the purpose of finding an experimental answer to the questions previously posed.

1. Preliminary remark

From 2008 to 2010 I carried out research work on a large number of red stars with a (B-V) colour index comprised between 1.0 and 2.0 and the majority of the stars examined had turned out to be very close to the Sun. That was the result of parallax measurements performed on the basis of pictures taken from Observatory 610 at Pianoro (Bologna, Italy).

On the contrary, the distances of the same stars reported in the Tycho and Hipparcos Catalogues are on average longer respectively by one and by two orders of magnitude.

2. Description of the proposed programme

I chose 20 stars that would be visible in the period August-December 2011 from about 200 stars which I had observed over a span of two years. The sky zone concerned went from h 20:30 to h 21:00 Right Ascension and from +21° to +60° Declination.

I drew the H-R diagram of this zone with the 2,668 stars reported in the Hipparcos Catalogue (Figure 5), but this time:
the colour **yellow** shows the stars with a (B-V) colour index < 1;
the colour **red** shows the stars with a (B-V) colour index > 1;
the colour **green** shows the stars with a proper motion > 0.100 arcseconds. The last ones constitute the main sequence and only few of them are Giants or Supergiants while the other stars examined by the satellite turn out to be nearly all “Giants” or “Supergiants”.
The ‘colour’ **black** shows the stars that later would be studied at Loiano.

From an exam of that initial diagram we can infer that:
1. If we leave out the stars (green in Figure 5) having proper motions greater than 0.100 arcseconds (most of which had been measured with great precision from the ground before the Hipparcos Mission), we can notice that the remaining stars are generally at distances greater than 200 parsecs, i.e. they are Giants (in some cases even Supergiants), like Prof. Kovalevsky had pointed out.
2. The stars (red in Figure 5) with a (B-V) colour index >1 have absolute magnitude variable from -4 to +3 (Red Giants) and there are no Red Dwarfs with absolute magnitude between +5 and +15.
3. In the Hipparcos Catalogue the total number of the stars examined in the sky zone observed is 2,668 and the absolute magnitude of the stars with a negative parallax angle or with an angle narrower than the measurement error is not reported.
Among them there are 724 red stars with (B-V) >1, in their turn subdivided into 66 with parallaxes smaller than the measurement error, 32 with negative parallaxes and the rest with positive parallaxes but with values lower than about 10 mas.
4. The fact that 724 Red Giants and Red Supergiants are present but there are no Red Dwarfs shows an enormously disproportionate selection effect.

3. Implementation

Thanks to Prof. Alberto Buzzoni, the University of Bologna gave permission to use its telescope at Loiano to conduct research on some red stars visible from August to December 2011.

The following list of the selected stars is the very same as sent to Ms Silvia Galleti, who was to capture the first images with the telescope. Then she was to capture the second set of images of the same stars three months later (at about h 19:00 UT so that to have the stars again at meridian).

List of Objects

1st group (10 images of each star around August 5th, 2011) (at meridian ≅ h 1:00 UT)

Catalogue No.	Coordinates (2000.0) RA	Dec	(B-V) J.	Absolute M	Apparent m	Notes
HIP 101198	20 30 46	+27 57 31	1.133	1.2	8.10	
" 101978	20 39 59	+58 53 39	1.807	-0.6	8.45	
" 102788	20 49 29	+42 38 21	1.803	-6.0 ?	8.49	
" 103961	21 03 51	+57 53 30	1.972	0.70	8.69	
" 104217	21 06 51	+38 44 29	1.069	7.490	5.20	**61Cyg A** (verification)
" 104214	21 06 52	+38 44 04	1.309	8.327	6.05	**61Cyg B** (")
" 104039	21 04 40	+30 55 05	1.078	0.96	8.62	
" 104763	21 13 25	+38 24 08	1.329	-0.64	7.74	

2nd group (10 images of each star around August 20th, 2011) (at meridian ≅ h 1:00 UT)

Catalogue No.	Coordinates (2000.0) RA	Dec	(B-V) J.	Absolute M	Apparent m	Notes
HIP 105471	21 21 47	+30 47 05	1.614	-6.0 ?	8.45	
" 105812	21 25 47	+52 51 43	1.542	0.38	7.66	
" 107076	21 41 16	+48 20 03	1.179	0.78	8.25	
GSC 3976 637	21 54 51	+57 19 46	2.1 ?	4.6	8.72	
" 3980 1234	21 53 42	+58 10 10	2.2 ?	?	9.54	

3rd group (10 images of each star around August 25th, 2011) (at meridian ≅ h 1:00 UT)

Catalogue No.	Coordinates (2000.0) RA	Dec	(B-V) J.	Absolute M	Apparent m	Notes
HIP 108981	22 04 42	+46 25 38	0.157	-6.0 ?	10.1	**SS Lac** (Algoltype eclips.
GSC 3605 2627	22 05 45	+46 17 31	1.9 ?	4.3	8.78	var. star)
" 3605 2721	22 05 59	+46 27 17	2.2 ?	-6.0 ?	8.99	
HIP 110 893	22 28 00	+57 41 49	1.613	11.576	9.74	**Kruger 60** (verification)
" 113414	22 58 09	+30 21 55	1.616	-8.0 ?	8.46	

4th group (10 images of each star around September 21st, 2011) (at meridian ≅ h 1:00 UT)

Catalogue No.	Coordinates (2000.0) RA	Dec	(B-V) J.	Absolute M	Apparent m	Notes
HIP 117972	23 55 41	+25 08 38	0.924	5.54	9.03	
GSC 1728 1298	23 58 21	+21 47 27	2.0 ?	-6.0 ?	9.60	{ Double?
" 1728 345	23 58 36	+21 45 05	0.546	3.1	8.33	{ " ?

HIPPARCOS STARS

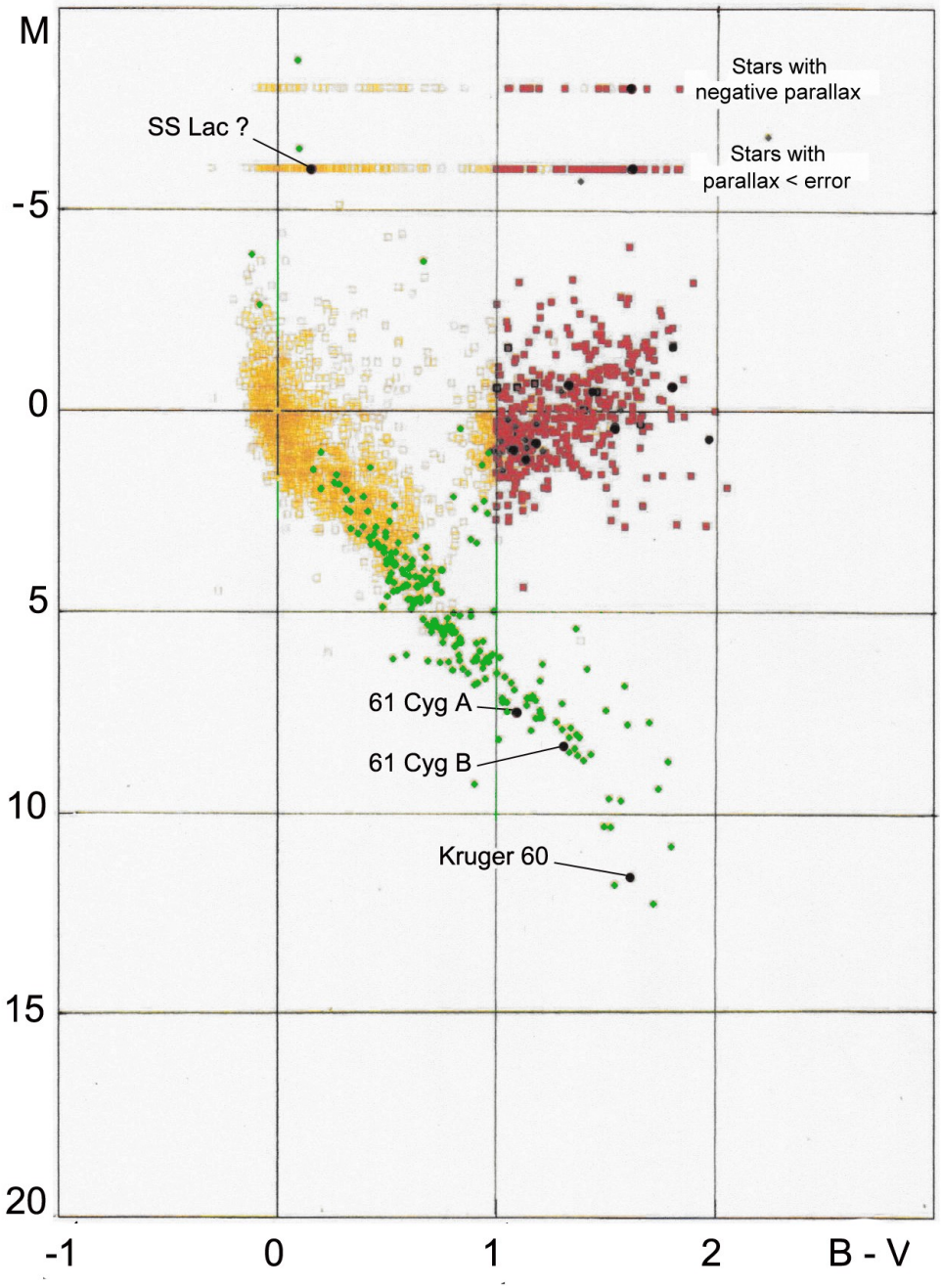

Figure 5

TABLE

HIPPARCOS STARS (Data from the catalogue except for the absolute magnitude M of the four stars written in green)							RESULTS OF THIS RESEARCH		
Catalogue No.	m	M	B-V	Trig. Parallax mas	Distance parsec	Spectr.	M	B-V	Parallax mas
			61 Cyg (a) and 61 Cyg (b)						
104214	5.20	7.49	1.069 ± 0.015	285.13 ± 1.51	3.483 ± 0.018	K5 V	8.5	1.1	451 ±120
104217	6.05	8.33	1.309 ± 0.012	285.42 ± 0.72	3.504 ± 0.009	K7 V	8.8	1.3	351 ± 60
101198	8.09	1.2	1.133 ± 0.014	4.18 ±1.08	239 ± 62	K2 III	11.3	1.8	414 ± 32
101978	8.45	-0.6	1.807 ± 0.035	0.98 ± 0.65	1020 ± 680	K7	13.5	1.8	909 ± 70
102788	8.50	-0.6	1.803 ± 0.036	1.52 ± 0.87	660 ± 380	M0	11.2	1.7	313 ± 47
104039	8.61	0.96	1.078 ± 0.020	2.95 ± 1.15	340 ± 130	K0	11.6	1.8	374 ± 50
104763	7.77	-0.64	1.329 ± 0.012	2.08 ± 0.77	480 ± 180	K5	12.4	1.6	804 ± 38
105471	8.45	-6.00	1.614 ± 0.026	***0.84 ± 1.12***	?	K5	11.9	1.6	451 ± 43
105812	7.68	0.38	1.542 ± 0.018	3.47 ± 0.70	288 ± 58	K5	10.0	1.5	270 ± 50
107076	8.27	0.78	1.179 ± 0.017	3.17 ± 0.84	315 ± 84	K0	13.9	1.8	937 ± 70
			Kruger 60						
110893	9.95	11.58	1.613 ± 0.003	249.52 ± 3.03	4.008 ± 0.049	M2 V	12.1	1.6	262 ± 21
			SS Lac (eclipsing binary)						
108981	10.1	-6.00	0.157 ± 0.055	***1.13 ± 1.39***	?	B7	12.4	0.1	226 ± 17
113414	9.6	-8.00	1.616 ± 0.143	***-0.44 ± 1.48***	?	M0	11.3	1.6	208 ± 30
113420	8.5	-8.00	1.616 ± 0.143	***-0.09 ± 1.10***	?	M0	13.9	1.6	234 ± 42

-

GSC STARS (Data from the Tycho Catalogue)							RESULTS OF THIS RESEARCH		
3976 637	8.72	4.6	2.2 ?	15 ± 11	67 ± 49	?	8.8	?	93 ± 32
3980 68	8.94	5.55	1.374	21 ± 9	48 ± 20	?	13.1	1.4	618 ± 87
3980 1234	9.54	?	2.2 ?	15 ± 15	?	?	10.1	1.6	115 ± 35
3605 2627	8.78	4.3	1.9 ?	13 ± 12	77 ± 71	?	12.7	1.9	624 ± 42
3605 2721	8.99	?	2.2 ?	3 ± 15	?	?	12.0	1.8	325 ± 39

From a first exam of the table we can notice that:

1. 61 Cyg (a), 61 Cyg (b) and Kruger 60 have been used for verification purposes.
2. The four stars written in green have parallax angles narrower than the measurement error. Their absolute magnitude M is not given in the Hipparcos Catalogue and they are supposed to be very far away. I assumed the value M = -6.00 for the first two stars and the value M = -8.00 for the other two with negative parallaxes (the multiple star formed by HIP 113414 and HIP 113420), so as to make it possible to show them in the H-R diagram.

3. From the calculations done, the three underlined stars HIP 101978, HIP 104763 and HIP 107076 turn out to be closer to the Sun than α Centauri as they have parallax angles > 750 mas.
   Of course, those stars must be carefully studied in order to verify this preliminary result.
4. The parallax angles calculated in this research turn out to be ≅ > by two orders of magnitude than the parallax angles of the stars of the Hipparcos Catalogue, while for the five stars of the Tycho Catalogue they are nearly all ≅ > by one order.

The questions that arise and a possible explanation are dealt with at the end of Part I. But I wish to make clear that "if" the star distances are proved to be in the average ten times or more shorter than those given in the official catalogues "then" the star density of this part of our galaxy must be at least a thousand times greater than believed till now.

The Hertzsprung-Russell diagram on the following page (Figure 6) shows the results of the research conducted at Loiano Observatory. The positions of the ten stars under observation (nine Red and one White, SS Lac 108981) are astoundingly different from the positions given in the catalogue.

H-R DIAGRAM SHOWING THE POSITION OF THE STARS OF THE HIPPARCOS CATALOGUE OBJECT OF THIS RESEARCH

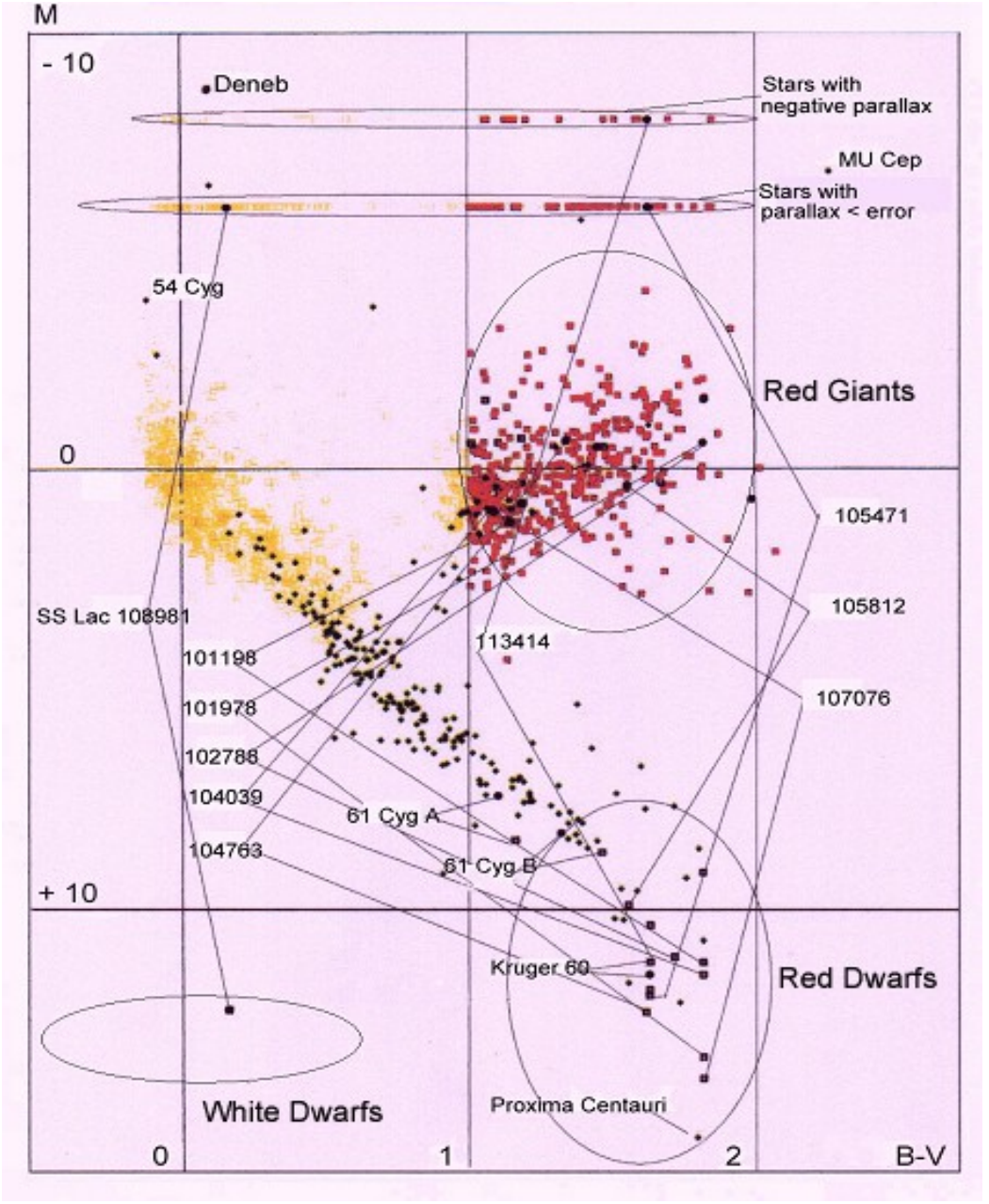

Figure 6

The above H-R diagram shows that the stars given as Red Giants in the Hipparcos Catalogue are Red Dwarfs according to these measurements. Also SS Lac 108981 is a White Dwarf, not a Giant.

APPENDIX

The following table draws up a list of some Dwarfs of the northern hemisphere (except for one) whose distances, as measured by Observatory 610 in the period 2008-2011, are shorter than 6 ly.

GSC No.	HIP No.	RA J2000.0 h m s	Dec ° ′ ″	Parallax mas	Parallax (610) mas	Distance (610) l y
2259 803		00 00 00.74	+ 31 31 55.6	3 ± 16	**1122 ± 100**	**2.9 ± 0.3**
2259 741		00 01 12.77	+ 31 29 48.1	47 ± 39	**767 ± 90**	**4.3 ± 0.6**
1729 911		00 02 54.56	+ 24 48 55.3	62 ± 38	**757 ± 100**	**4.3 ± 1.0**
2267 310		00 03 09.61	+ 35 29 58.5	- 10 ± 27	**725 ± 100**	**4.5 ± 1.0**
3247 499	995	00 12 26.38	+ 45 57 34.6	3.99 ± 1.02	**605 ± 50**	**5.4 ± 1.0**
3276 733		01 13 13.31	+ 51 05 42.6	32 ± 17	**1426 ± 150**	**2.3 ± 0.3**
715 1539		05 51 39.40	+ 07 32 30.4	- 24 ± 18	**979 ± 150**	**3.3 ± 0.6**
136 42006		06 20 02.50	+ 02 52 29.9	5 ± 16	**1093 ± 100**	**3.0 ± 0.3**
1894 1040		06 53 21.98	+ 23 01 31.6	53 ± 29	**781 ± 70**	**4.2 ± 0.4**
3064 855	78741	16 04 29.27	+ 41 22 02.1	- 0.05 ± 1.10	**1209 ± 100**	**2.7 ± 0.5**
3064 424		16 04 27.60	+ 41 09 57.5	-9 ± 16	**586 ± 100**	**5.6 ± 1.0**
967 811	80332	16 23 59.97	+ 12 51 57.7	4.04 ± 1.48	**703 ± 80**	**4.6 ± 0.5**
967 1049		16 23 58.38	+ 12 52 59.5	29 ± 36	**602 ± 80**	**5.4 ± 0.8**
2056 506	80882	16 30 54.74	+ 29 12 15.5	1.90 ± 1.11	**617 ± 80**	**5.3 ± 0.5**
2056 1479		16 31 15.19	+ 29 12 34.5	91 ± 35	**618 ± 80**	**5.3 ± 0.5**
3063 1149	81260	16 35 49.90	+ 39 32 35.5	4.18 ± 0.98	**605 ± 80**	**5.4 ± 0.5**
5642 496		16 53 07.28	- 08 23 30.6	-26 ± 21	**635 ± 80**	**5.1 ± 1.0**
425 2502	**87937**	**17 57 48.97**	**+ 04 40 05.8**	**549 ± 1.61**	**558 ± 80**	**5.8 ± 0.5**
?	?	17 57 11.03	+ 14 42 08.6	?	**1465 ± 180**	**2.2 ± 0.2**
?	?	18 51 42.18	+ 20 47 55.2	?	**700 ± 150**	**4.7 ± 0.5**
4229 1025	94162	19 10 02.33	+ 66 06 09.7	3.13 ± 0.76	**754 ± 90**	**4.3 ± 1.0**
?	?	19 14 44.70	+ 00 00 44.6	?	**821 ± 190**	**4.0 ± 0.8**
394 1291		20 08 44.93	+ 58 10 10.2	?	**682 ± 90**	**4.8 ± 0.6**
3937 155		20 19 05.89	+ 54 11 00.7	?	**946 ± 90**	**3.5 ± 0.3**
3941 1203		20 21 37.08	+ 55 22 18.2	13 ± 9	**1188 ± 150**	**2.7 ± 0.4**
?	?	20 24 25.86	+ 29 42 02.2	?	**1133 ± 300**	**2.9 ± 1.0**
?	?	20 23 31.68	+ 29 25 45.8	?	**1969 ± 180**	**1.7 ± 0.2**
3573 301	100870	20 27 09.41	+ 45 41 02.5	2.60 ± 0.74	**580 ± 90**	**5.6 ± 1.0**
3573 129		**20 26 48.51**	**+ 45 37 16.3**	**?**	**3105 ± 200**	**1.05 ± 0.10**
4233 528		20 28 04.07	+ 60 52 40.7	14 ± 13	**733 ± 80**	**4.5 ± 0.5**
2168 138		20 27 47.71	+ 29 57 09.3	21 ± 9	**647 ± 80**	**5.0 ± 0.6**
3587 432		20 52 42.15	+ 51 14 55.6	?	**1088 ± 200**	**3.0 ± 0.6**
?	?	21 26 14.77	+ 52 47 10.9	?	**559 ± 80**	**5.8 ± 1.0**
?	?	21 56 10.48	+ 57 16 17.3	?	**1049 ± 150**	**3.1 ± 0.4**
?	?	21 52 52.56	+ 58 03 07.5	?	**949 ± 50**	**3.4 ± 0.2**

Observe that only in the case of **Barnard's Star (GSC 425 2502 in bold type)** the parallax angle of the official catalogues coincides with that of Observatory 610. Moreover, the **second star in bold type (GSC 3573 129)**, one of the stars whose parallax angles had not yet been measured by anyone, **stands out with a distance from the Sun of (1.05 ± 0.10) light years.**

The last measurement, if confirmed by other observatories, makes us think that GSC 3573 129 must be a companion of our Sun.

Curriculum Vitae

Vittorio B. Goretti graduated in Physics from Bologna University in 1965.

Besides working as a teacher in secondary education, he devoted his time to research work on asteroids over a period of 25 years.
He worked at S. Vittore Observatory in Bologna and, for a while, at Asiago Observatory.
Since 1995 his research work has continued from his private Observatory 610 at Pianoro.
His research effort resulted in measurements for thousands of asteroids, among which a great number of NEA (Near Earth Asteroids). He discovered over 32 new asteroids.
He is currently focusing on stars near the Sun employing the Trigonometric Parallax method.

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Hipparcos Catalogue

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