INDICATIONS OF A GENERAL ANISOTROPY OF THE UNIVERSE

H.H.FLICHE, J.M.SOURIAU, R.TRIAY

Université de Provence et Centre de Physique Théorique, Marseille

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Address for proofs:
J.M. SOURIAU
C.N.R.S.-Luminy- case 907
Centre de Physique Théorique
F-13288 MARSEILLE CEDEX 2
FRANCE

This is a sequel to the preprint CPT/P.1196 (1980) with the title "Bipartition of the Universe", which will be denoted by Paper I.

Key Words: Cosmology, Quasars, Galaxies, Clusters, Background Radiation

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I. CONFRONTATION WITH NEW DATA ON QUASARS

We have collected all new publications on quasars in the last year (see References below); the catalog assembled by one of us (R.T.) contains now 1095 objects with confirmed redshift. The number of objects located in a neighbourhood of zone (S) has increased by 75 %.

The data are shown on Fig. 1, which should be compared with Fig. 5 of Paper I. On notices that THE EMPTY ZONE (S) HAS SURVIVED, a large number of new points notwithstanding. Its width has decreased by about 1/3, but its statistical significance has remained approximatively unchanged (the adjacent zones of equal width contain, respectively, 19 and 20 objects). This is what one expects of a real phenomenon about which increasing information is gathered through new observations. If, on the other hand, the empty zone were due to chance, the probability of its being respected by the new data would be very small.

In Paper I (Table II) we pointed out 9 objects whose first publications were incompatible with the existence of (S); we suggested new observations as a test of our assumptions. In the meantime, individual spectra of these objects have been published (Osmer (1980); Osmer & al.(1980)); they are included in the new data above. Consequently, THE PROPOSED TEST HAS BEEN ANSWERED POSITIVELY.

The set of all data available as of now leads, by optimization, to the following values:

-the direction orthogonal to (S) is, in equatorial coordinates

(1) $$(5h\ 47\ min,\ +6^{\circ}\ 40')$$

which should be compared with the value (1) and (2) of Paper I. Notice that (1) has moved toward the first value, obtained from the clouds $\alpha, \beta, \gamma, \delta$ only; consequently the clouds are still contained in (S) (within the accuracy of the data).

-the cosmological parameters are

(2) $$\Omega_0 = 0.08,\ q_0 = -1.12,\ k = 0.24$$

(in Paper I, the values were $\Omega_0 = 0.05$, $q_0 = -1.11$, $k = 0.20$). The new values are sufficiently close to the old ones to leave unchanged the properties of the cosmological model described in Paper I. With these values, the age of the Universe is 17 billion years (taking $H_0 = 100$ km /s /Mpc). An interesting property of this model is to ELIMINATE THE PARADOX OF THE ISOTROPY OF BACKGROUND RADIATION (in the standard model with negative curvature, the sources of radiation in different directions are causally independent). Here finiteness of space together with a focalization effect (for z # 200) shows that the sources of 3°K radiation are physically close together; it is not necessary to postulate arbitrarily a strict initial symmetry to explain the data. Present-day symmetry can thus be explained as a simple evolutionary effect, due to the expansion, starting with an initial anisotropic structure.

-the cosmic latitude of the Earth is

(3) $$l = 25^{\circ}\ 30'$$

(compare Paper I, IV, a).

II. GENERAL ANISOTROPY AND NEARBY GALAXIES

We have indicated in Paper I that the spatial distribution of quasars indicated a possibility of general stratification parallel to (S), stratification which would be difficult to observe for technical reasons. It is natural to ask whether this stratification extends down to the level of galaxies (Souriau (1980)).

G. de Vaucouleurs (1981) has pointed out to us that the galaxies of the Local Group are distributed on a flat disk, the direction of which is very close to the stratification plane defined by (S).

On can verify this by constructing a map of the sky in "cosmic coordinates" CL, CB (such that the pole CB = 90° coincides with the direction (1)). On Fig. 2 obtained in this way, we have given the positions of the "outstanding galaxies", defined in de Vaucouleurs (1975), with distances less than 10 Mpc. We notice that THESE GALAXIES ARE ALMOST CONFINED TO THE BAND -30° ≤ CB ≤ 30°, which contains only half of the sky surface. Moreover, the principal nearby clusters, Virgo and Coma, are also in this zone.

There is another extragalactic structure that has the same sky distribution, the H I clouds that are observed, in particular, near the Magellanic clouds. They are shown on Fig. 3, which is established from de Vaucouleurs & al. (1975). WE NOTICE THAT THESE CLOUDS ARE ALSO PREFERENTIALLY SITUATED IN THE SAME ZONE -30° ≤ CB ≤ 30°.

III. KINEMATIC ANISOTROPY

If the suspected stratification is permanent, the relative velocities of the components of a given region have to be parallel to this stratification. We forecast so a planar kinematics, orthogonal to the direction (1).

A certain number of velocities of this kind have been measured, allowing a verification of this hypothesis. Fig. 4 is borrowed from de Vaucouleurs & al. (1981); we find in it the apex of the Sun with respect to: the background radiation (denoted by S/*), the Local Group of galaxies (S/L), and to a sample of 300 galaxies chosen in the distance 3-32 Mpc (S/G). The first number is an average of several published measurements (Smoot & al. (1977); Corey (1978); Gorenstein (1978); Cheng & al. (1979); Cheng & al. (1980)). The other two follow from a new study that uses the radio-astronomical Tully-Fischer method.

WE NOTICE THAT THESE POINTS ARE LOCATED, WITHIN THE PRECISION OF THE MEASUREMENTS, ON THE LINE PARALLEL TO THE DIRECTION OF (S) (CB = 0°); similarly of course for the relative apexes: Local Group /galaxies (L/G), Local Group/ 3.K (L/*), galaxies/ 3.K (G/*).

It is the last three apexes that are most significant, since they are obtained by elimination of the proper motion of the Sun with respect to the Galaxy. The direction of their plane differs by only 2 degrees from the direction defined by (1); within the given precision, the two directions coincide.

Thus, these observations confirm the hypothesis: THE GENERAL KINEMATICS OF OBJECTS BETWEEN 0 AND 30 Mpc SEEMS PLANAR, AND EXACTLY TO THE DIRECTION DEFINED BY (1).

IV. CONCLUSIONS

Quite diverse observations (quasars, galaxies, blackbody radiation) made in most regions of the sky have confirmed the cosmological structure that we proposed (Souriau (1979), (1980)); this model would have been eliminated if a few observations had given different results. If the conclusions of Sec. II and III above are confirmed, they indicate that matter is stratified, geometrically and kinematically, in all of the Universe; otherwise we would be forced to assume that we live in an exceptional region.

The easiest additional verifications involve the distribution of quasars in the neighbourhood of the zone (S). An exhaustive search for all quasars in a limited region of the sky (e.g. 5° X 5°) in a given zone of redshifts has already been performed (by Osmer & al.). The region of Pegasus (22h 30 mn, + 15°) or that of Virgo (13 h, 0°) correspond to relevant redshifts centered around z = 2 (see Table I), which are particularly easy to observe. One or two searches of this kind should bring about virtual certainty about the objective existence of the empty zone (S).

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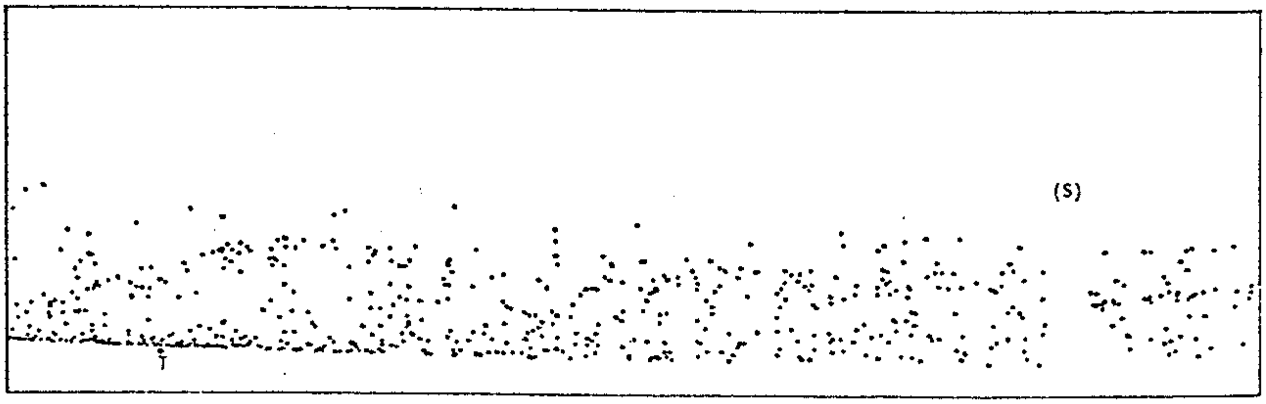

FIGURE 1

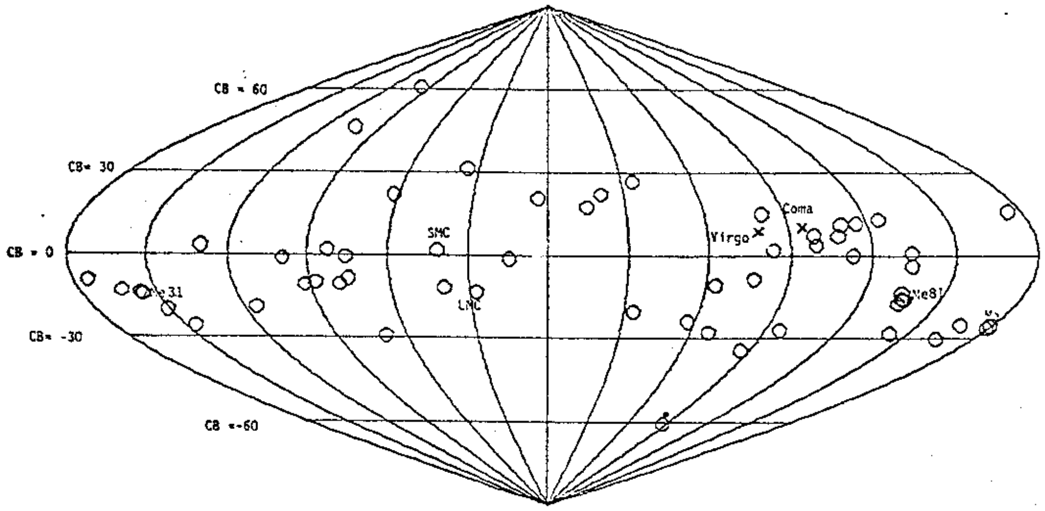

FIGURE 2

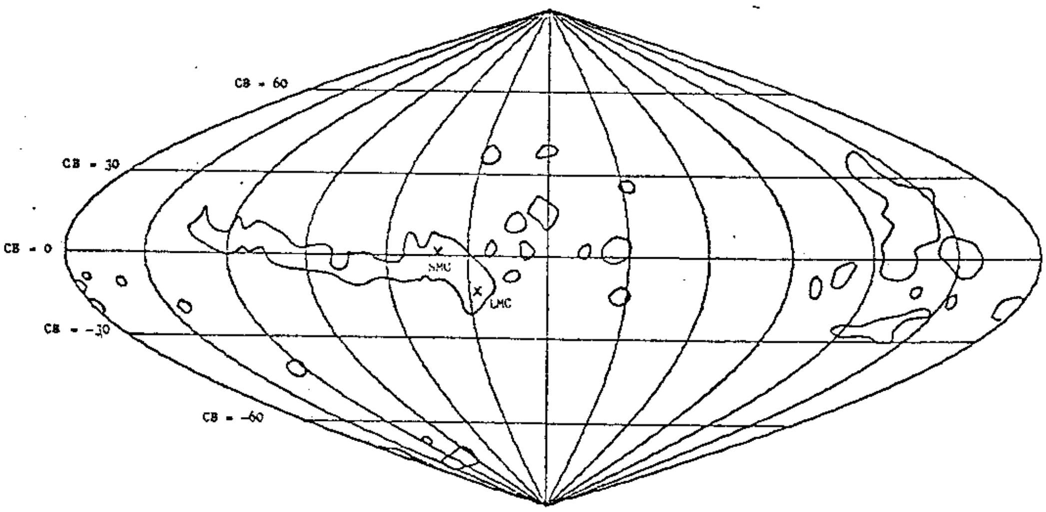

FIGURE 3

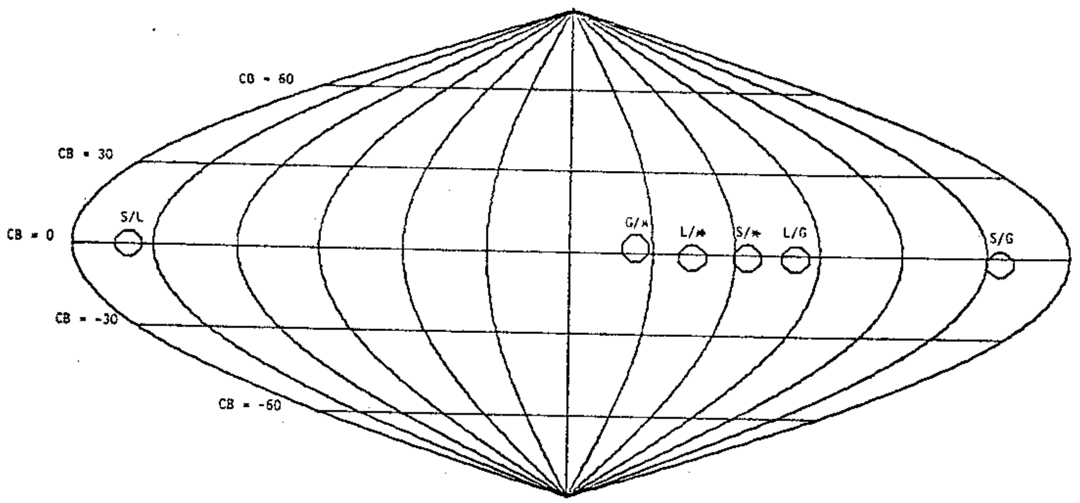

FIGURE 4

Table I, updating Table 1 of Paper I

Forbidden zone for redshifts versus angular distance to:

* (17h 47mn, -6°40')

0	0.851	0.896
5	0.854	0.899
10	0.862	0.907
15	0.877	0.922
20	0.897	0.943
25	0.924	0.972
30	0.959	1.008
35	1.003	1.054
40	1.057	1.112
45	1.125	1.182
50	1.208	1.269
55	1.311	1.377
60	1.439	1.512
65	1.600	1.681
70	1.805	1.897
75	2.069	2.178
80	2.416	2.548
85	2.875	3.041
90	3.483	3.698

QUASARS REFERENCES (PAPER II)

ADAMS,M.T.,RUDNICK,L.:1977,ASTRON.J.82,857
ARGUE,A.N.,SULLIVAN,C.:1980,MONTHLY NOTICES ROY.ASTRON.SOC.192,779
ARP,H.C.,DE RUITER,H.R.,WILLIS,A.G.:1979,ASTRON.ASTROPHYS.77,86
ARP,H.,SULENTIC,J.W.:1979,ASTROPHYS.J.229,496
ARP,H.,SARGENT,W.L.W.,WILLIS,A.G.,OOSTERBAAN,C.E.:1979,ASTROPHYS.J.230,68
ARP,H.,SULENTIC,J.W.,DI TULLIO,G.:1979,ASTROPHYS.J.229,489
APP,A.:1976,ASTROPHYS.J.210,L59
ARP,H.:1980,ASTROPHYS.J.236,63
BLADES,J.C.,MURDOCH,H.S.,HUNSTEAD,R.W.:1980,MONTHLY NOTICES ROY.ASTRON.SOC.
191,61
BOHUSKI,T.J.,FAIRALL,A.P.,WEEDMAN,D.W.:1978,ASTROPHYS.J.221,776
BOHUSKI,T.J.,WEEDMAN,D.W.:1979,ASTROPHYS.J.231,653
BOKSEMBERG,A.,DANZIGER,I.J.,FOSBURY,R.A.E.,GOSS,W.M.:1980,PREPRINT 115
BOLTON,J.G.,SAVAGE,A.,WRIGHT,E.:1979,AUST.J.PHYS.ASTROPHYS.SUPPL.46
BOZYAN,E.P.:1979,ASTRON.J.84,910
BURBIDGE,E.M.,JUNKKARINEN,V.,KOSKI,A.T.:1979,ASTROPHYS.J.233,L97
BURBIDGE,G.R.,HEWITT,A.:1980,ASTROPHYS.J.SUPPL.43,57
BURBIDGE,G.R.,HEWITT,A.:1980,PRIV.COMM.
CANIZARES,C.R.,MC CLINTOCK,J.E.,RICKER,G.R.:1978,ASTROPHYS.J.226,L1
CARSWELL,R.F.,HILLIARD,R.L.,STRITTAMATTER,P.A.,TAYLOR,D.J.,WEYMANN,R.J.:1975
ASTROPHYS.J.196,351
GIACCONI,R.,BECHTOLD,J.,BRANDUARDI,G.,FORMAN,W.,HENRY,J.P.,JONES,C.,
KELLOGG,E.,VAN DER LAAN,H.,LILLER,W.,,MARSHALL,H.,MURRAY,S.S.,PYE,J.,
SHREIER,E.,SARGENT,W.L.W.,SEWARD,F.,TANABAUM,H.:1979,ASTROPHYS.J.234,L1
GILMORE,G.:1980,MONTHLY NOTICES ROY.ASTRON.SOC.190,649
GREEN,R.F.,SCHMIDT,M.:1978,ASTROPHYS.J.220,L1
GREEN,R.F.,PIER,J.R.,SCHMIDT,M.,ESTABROOK,F.B.,LANE,A.L.,WAHLQUIST,H.D.:
1980,ASTROPHYS.J.239,483
GRINDLAY,J.E.,STEINER,J.E.,FORMAN,W.R.,CANIZARES,C.R.,MC CLINTOCK,J.E.:1980
ASTROPHYS.J.239,L43
HAWLEY,S.A.,MILLER,J.S.,WEYMANN,R.J.:1977,ASTROPHYS.J.213,632
HAZARD,C.,ARP,H.C.,MORTON,D.C.:1979,NATURE 282,271
HUNSTEAD,R.W.,MURDOCH,H.S.:1980,MONTHLY NOTICES ROY.ASTRON.SOC.192,31P
KRONBERG,P.P.,BURBIDGE,E.M.,SMITH,H.E.,STROM,R.G.:1977,ASTRPHYS.J.216,[illegible]
KRONBERG,P.P.,CLARKE,J.N.,VAN DEN BERGH,S.:1980,ASTRON.J.85,973
LEVSHAKOV,S.A.,VARSHALOVICH,D.A.:1979,ASTROPHYS.LETT.20,67
LEWIS,D.W.,MACALPINE,G.M.,WEEDMAN,D.W.:1979,ASTROPHYS.J.233,787
LEWIS,D.W.,MACALPINE,G.M.,SMITH,S.B.:1977,ASTROPHYS.J.SUPPL.34,95
LEWIS,D.W.,MACALPINE,G.M.,SMITH,S.B.:1977,ASTROPHYS.J.SUPPL.35,197
LEWIS,D.W.,MACALPINE,G.M.,SMITH,S.B.:1977,ASTROPHYS.J.SUPPL.35,203
LEWIS,D.W.,MACALPINE,G.M.:1978,ASTROPHYS.J.SUPPL.36,587
MARASCHI,L.,TANZI,E.G.,TARENGHI,M.,TREVES,A.:1980,NATURE 285,555
MARGON,B.,KWITTER,B.K.:1978,ASTROPHYS.J.224,L43
MORTON,D.C.,SAVAGE,A.,BOLTON,J.G.:1978,MONTHLY NOTICES ROY.ASTRON.SOC.
185,735
OSMER,P.S.,SMITH,M.G.:1977,ASTROPHYS.J.213,607
OSMER,P.S.:1977,ASTROPHYS.J.216,L89
OSMER,P.S.,SMITH,M.G.:1977,ASTROPHYS.J.217,L73
OSMER,P.S.,SMITH,M.G.:1977,ASTROPHY.J.215,L47
OSMER,P.:1980,ASTROPHYS.J.237,666
OSMER,P.S.,SMITH,M.G.:1980,ASTROPHYS.J.SUPPL.42,333
OSMER,P.S.:1980,ASTROPHYS.J.SUPPL.42,523
OSTERBROCK,D.E.,GRANDI,S.A.,COHEN,R.D.:1978,PUBL.ASTRON.SOC.PACIFIC 90,493
OWEN,F.N.,PORCAS,R.W.,NEFF,S.G.:1978,ASTRON.J.83,1009
PETERSON,B.M.,CRAINE,E.R.,STRITTMATTER,P.A.:1978,PUBL.ASTRON.SOC.PACIFIC
90,386.
PETERSON,B.M.,STRITTMATTER,P.A.:1978,ASTROPHYS.J.226,21
PETERSON,D.L.,WRIGHT,A.E.,CONDON,J.J.:1978,ASTROPHYS.J.222,L81
PHILLIPS,M.M.,HAWLEY,S.A.:1979,PUBL.ASTRON.SOC.PAC.90,650
PHILLIPS,M.M.:1980,ASTROPHYS.J.236,L46
PUETTER,R.C.,SMITH,H.E.,WILLNER,S.P.:1979,ASTROPHYS.J.227,L5
PUSCHELL,J.J.,STEIN,W.A.,JONES,T.W.,WARNER,J.W.,OWEN,F.,RUDNICK,L.,ALLER,H.,
HODGE,P.:1979,ASTROPHYS.J.227,L11
RICHSTONE,D.O.,SCHMIDT,M.:1980,ASTROPHYS.J.235,361
ROBERTS,A.H.,BURBIDGE,E.M.,BURBIDGE,G.R.,CROWNE,A.H.,JUNKKARINEN,V.T.,
SMITH,H.E.:1978,ASTROPHYS.J.224,344

SAVAGE,A.,BROWNE,I.W.A.,BOLTON,J.G.:1976,MONTHLY NOTICES ROY.ASTRON.SOC. 177,77P
SAVAGE,A.,BOLTON,J.G.,WRIGHT,A.E.:1977,MONTHLY NOTICES ROY.ASTRON.SOC. 179,135
SCHMIDT,M.:1977,ASTROPHYS.J.217,358
SMITH,H.E.,BURBIDGE,E.M.,BALDWIN,J.A.,THOLINE,J.E.,WAMPLER,E.J.HAZARD,C., MURDOCH,H.S.:1977,ASTROPHYS.J.215,427
SMITH,H.E.,SPINRAD,H.:1980,ASTROPHYS.J.236,419
SMITH,M.G.,WRIGHT,A.E.:1980,MONTHLY NOTICES ROY.ASTRON.SOC.191,871
SOIFER,B.T.,OKE,J.B.,MATTHEWS,K.,NEUGEBAUER,G.:1979,ASTROPHYS.J.227,L1
SPINRAD,H.,KRON,R.G.,HUNSTEAD,R.W.:1979,ASTROPHYS.J.SUPPL.41,701
SRAMEK,R.A.,WEEDMAN,D.W.:1980,ASTROPHYS.J.238,435
STOCKE,J.,ARP,H.:1978,ASTROPHYS.J.219,367
TANABAUM,H.,AVNI,Y.,BRANDUARDI,G.,ELVIS,M.,FABBIANO,G.,FEIGELSON,E. GIACCONI,R.,HENRY,J.P.,PYE,J.P.,SOLTAN,A.,ZAMORANI,G.:1979,ASTROPHYS.J. 234,L9
THUAN,T.X.,OKE,J.B.,BERGERON,J.:1979,ASTROPHYS.J.230,340
TURNSHEK,D.A.,WEYMANN,R.J.,LIEBERT,J.W.,WILLIAMS,R.E.,STRITTMATTER,P.A.:1980 ASTROPHYS.J.238,488
ULRICH,M.H.,BOKSENBERG,A.,BROMAGE,G.,CARSWELL,R.,ELVIUS,A.,GABRIEL,A. GONDHALEKAR,P.M.,LIND,J.,LINDEGREN,L.,LONGAIR,M.S.,PENSTON,M.V., PERRYMAN,M.A.C.,PETTINI,M.,PEROLA,G.C.,REES,M.,SCIAMA,D.,SNIJDERS,M.A.J. TANZI,E.,TARENGHI,M.,WILSON,R.:1980,MONTHLY NOTICES ROY.ASTRON.SOC.192,561
VAUCHER,B.G.,WEEDMAN,D.W.:1980,ASTROPHYS.J.240,10
WALTER,H.G.,WEST,R.M.:1980,ATRON.ASTROPHYS.86,1
WEILER,K.W.,JOHNSTON,K.J.:1980,MONTHLY NOTICES ROY.ASTRON.SOC.190,269
WEYMANN,R.J.,WILLIAMS,R.E.,BEAVER,E.A.,MILLER,J.S.:1977,ASTROPHYS.J.213,619
WEYMANN,R.J.,WILLIAMS,R.E.,PETERSON,B.M.,TURNSHEK,D.A.:1979,ASTROPHYS.J. 234,33
WEYMANN,R.J.,CHAFFEE,F.H.,DAVIS,M.,CARLETON,N.P.,WALSH,D.,CARSWELL,R.F.: 1979,ASTROPHYS.J.233,L43
WHELAN,J.A.J.,SMITH,M.G.,CARSWELL,R.F.:1979,MONTHLY NOTICES ROY.ASTRON.SOC. 189,363
WHELAN,J.A.J.,CARSWELL,R.F.,SMITH,M.G.:1977,MONTHLY NOTICES ROY.ASTRON.SOC. 181,81P
WHITE,G.L.,MURDOCH,H.S.,HUNSTEAD,R.W.:1980,MONTHLY NOTICES ROY.ASTRON.SOC. 192,545
WILKERSON,M.S.,COLEMAN,G.,GILBERT,G.,STRITTMATTER,P.A.,WILLIAMS,R.E., BALDWIN,J.A.,CARSWELL,R.F.,GRANDI,S.A.:1978,ASTROPHYS.J.223,364
WILLS,B.J.,WILLS,D.:1980,ASTROPHYS.J.238,1
WILLS,B.J.,WILLS,D.:1979,ASTROPHYS.J.SUPPL.41,689
WOLFE,A.M.,WILLS,B.J.:1977,ASTROPHYS.J.218,39
WOLFE,A.M.,DAVIS,M.M.:1979,ASTRON.J.84,699
WRIGHT,A.E.,PETERSON,B.A.,JAUNCEY,D.L.,CONDON,J.J.:1978,ASTROPHYS.J.226,L61

REFERENCES

CHENG,E.S.,SAULSON,P.R.,WILKINSON,D.T.,COREY,B.E.:1979,ASTROPHYS.J.232,L139
CHENG,E.S.,BOUGH,S.,WILKINSON,D.T.:1980,BULL.A.A.S. 12,488
COREY,B.E.:1978,PRINCETON U. DISSERTATION
DE VAUCOULEURS,G.:1975,ASTROPHYS.J.202,319
DE VAUCOULEURS,G.,CORWIN JR.,H.G.:1975,ASTROPHYS.J.202,327
DE VAUCOULEURS,G.,PETERS,W.L.,BOTTINELLI,L.,GOUGUENHEIM,L.,PATUREL,G.: "HUBBLE RATIO AND SOLAR MOTION FROM 300 SPIRALS HAVING DISTANCES DERIVED FROM HI LINE WIDTHS",PRE-PRINT 1981
DE VAUCOULEURS,G.:PRIV.COMMUNICATION 1981
GORENSTEIN,M.V.:1978,U. OF CALIFORNIA , DISSERTATION
SMOOT,G.F.,GORENSTEIN,M.V.,MULLER,R.A.:1977,PHYS.REV (LETTERS) 39,898
SOURIAU,J.M. : 1979 PREPRINT 79/P.1151 C.PT.-C.N.R.S. MARSEILLE
SOURIAU,J.M. : 1980 COLLOQUE DU CENTENAIRE EINSTEIN 197 C.N.R.S.