Kutner and Mead (30.155.036, 31.131.271, 34.131.105) reported detection of extensive low-level CO emission from molecular clouds well outside the solar circle, whose distribution apparently followed the HI warp. Solomon et al. (33.155.031) were unable to reproduce some aspects of those observations.

Work on the high-velocity cloud phenomenon involved several detailed studies of selected regions. Evidence for interaction of a high-velocity stream with the galactic disk was found by Cohen (30.131.006) in Jodrell Bank observations and by Mirabel (31.132.022) in Arecibo observations of the anticenter region. A survey by Cohen (32.131.021) of the Cetus region led to the conclusion that the high-velocity HI there is debris from the tidal interaction between our Galaxy and the Magellanic Clouds. Mirabel and Morras (37.155.063) published results from a search for high-velocity HI in a large area of the sky around the direction to the galactic center.

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V. Kinematics

A. STARS

1. Galactic Center

Wollman et al. (32.155.001) present high-resolution 2 μm spectra of three red giant stars in the core of the Galaxy. The properties of OH/IR stars were studied by Baud et al. (29.131.023), Olnon et al. (29.155.032), Habing et al. (34.155.048), and Baud (34.155.042). Vanderspeck and Ricker (34.041.001) determined absolute coordinates for 19 stars within 2' of the galactic center for epoch 1958.3 and 1976.3 and calculated their proper motions. Mould (33.155.013) obtained the radial-velocity dispersion for M stars in the nuclear bulge.

2. Disk and Solar Vicinity

Stetson (30.111.009) published a list of 371 A-F population I stars of high velocity determined from proper motion studies. Kibblewhite et al. (33.111.018) analyze proper motions of disk stars to obtain measures of the galactic differential rotation. Murray (34.155.108) discusses the kinematics of dwarf stars and obtains histograms of proper motion for 900 stars with $B < 14$ near the south galactic cap. An observational program to measure absolute proper motions of stars with respect to galaxies was described by Kharchenko (34.155.018).

Zentelis (34.111.004) measured the radial velocities of 353 BO-AO stars with $6.5 < V < 10.8$ in six galactic plane regions with a velocity uncertainty of 1.4 km/s. Fehrenbach and Burnage (29.111.003) and Fehrenbach et al. (32.111.001) published radial-velocity catalogues each containing four $4^{o} \times 4^{o}$ fields. Hartkopf and Yoss (32.155.062) obtained radial velocities for 302 polar giants.

A statistical study of 403 OB stars at $r < 630$ pc was performed by Quiroga and Tarsia (34.151.039) which shows that z motions are predominantly hydrodynamic. Ro-

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bertson (34.155.031) has made a comparison of the kinematics of M stars having M > 10.5 with K and M dwarfs selected from Gliese's catalogue. Lotkin (34.155.079) investigated the kinematics of 614 red giants in the solar vicinity and found differences between components of peculiar space velocities and the normal distribution. He also examines, in another work (33.155.101), the radial velocities of 369 B stars in the solar neighborhood and concludes that they exhibit equipartition of energy per unit mass. Kharachenko (33.155.060) uses absolute proper motions of stars to obtain kinematic characteristics of stellar groups. Yoshizawa (33.155.076) presents comments on stellar proper motion analyses and the velocity field in the solar neighborhood. An analysis of the kinematical properties of dwarfs grouped by spectral type was performed by Lee (31.155.022); Jahreiß and Wielen (34.155.123) used Gliese's catalogue to investigate the kinematical characteristics of stars in the solar neighborhod. Suchkov (33.155.001) examined the velocity ellipsoid of nearby dwarf stars. Gradients of the ellipsoid of the residual velocities in the galactic plane in the Π and Θ directions were calculated by Oblak (34.111.001). The correlation between X-ray luminosity and space velocity of nearby K dwarfs was analyzed by Johnson (34.155.127). Gliese (34.155.102) in a review of stars in the solar neighborhood, discussed a number of problems related to stellar velocity distributions.

Equations of the centroid and velocity disperion have been derived by Eelsalu (32.155.006) connecting the stellar-statistical kinematic data with the corresponding descriptive variables. He also considered (32.155.007) the special case of dispersion equations corresponding to high galactic latitudes. Nunez and Torra (31.155.050) calculated velocity momenta through the fourth order for different samples of Gliese's catalogue. Nunez and Figueras (34.155.125) calculated central momenta of the local velocity distribution to fourth order. Ogorodnikov and Osipkov (1980) considered the influence of high-velocity stars on estimating the dispersion of stellar velocities. Shuter and Goulet (34.155.126) analyze the radial velocities of 260 A V stars and show that they exhibit significant departures from pure circular motion. King (33.155.037) discusses possible reasons for the dip in the K_z curve derived from stellar kinematics.

Byl and Ovenden (30.155.001) performed numerical experiments of fictitious proper motions with and without spiral arms. Ardeberg and Maurice (29.155.038) studied radial-velocity data for young stars and gas on the inner border of the Carina arm. Using five samples totaling 500 stars, Berman and Mishurov (30.155.038) obtained the spiral structure parameters from a non-linear description of the stellar motion. Pavlovskaya and Suchkov (31.155.006) study statistical fluctuations in a sample of ∿ 150 stars within 3-4 kpc. Balázs (33.155.116) uses moderately old open clusters to determine the angular velocity of the local spiral arm pattern. Pellegatti Franco (34.155.052) finds that velocities of OB stars agree well with non-linear density-wave theory. The motions of 55 Cepheids were traced back in time by Grinev (34.155.067) who finds consistency with density-wave theory. Clube (34.155.124) reviews current attempts to establish peculiar motion of the local spiral arm. Gerasimenko (34.155.139) locates the inner edge of the Perseus arm from the velocity field of O-M stars.

Wyatt and Cahn (34.155.144) investigate the kinematics of 124 Mira variables and find the largest velocity dispersions in the oldest Miras. Baud et al. (29.131.022) observed the OH emission from 114 OH/IR stars and showed that there are two distinct kinematic groups related to the ages of the stars.

The slope dV/dl of the radial velocity of a feature close to $l = 0^o$ of $l = 180^o$ is shown by Rohlfs (30.155.030) to be a good measure of the distance to the galactic center. Palous (34.155.143) estimates the A,B,C and K constants from gradients in the U,V components in the X,Y plane. Vader and de Jong (30.155.002) constructed models of the galactic disk near the Sun by calculating the chemical and kinematic evolution of the gas. Lindblad (33.155.038) discusses the local expansion of gas and stars in terms of star formation and giant molecular clouds. Rohlfs and Kreitschmann (30.155.040) make a three component mass model of the Galaxy to, among other things, reproduce the rotation curve. Bahcall et al. (31.151.078) examine how various mass distributions can produce flat rotation curves out to 60 kpc. A review of the recent literature on the age distribution, kinematic properties and distribution over composition of the stellar component of the Galaxy was made by Mould (32.155.027).

3. Halo

Hartwick (34.115.075) finds that the kinematics of halo dwarfs and giants are similar to the RR Lyrae stars. Ratnatunga (33.155.057) discusses the kinematics and metal abundances of stars in the halo with respect to the formation and evolution of the Galaxy. Keenan and Dufton (34.114.031) find OB stars at high galactic latitude to be normal population I objects requiring ejection velocities > 100 km/s to be consistent with their lifetimes. A distant galactic RR Lyrae star was discovered by Hawkins (33.155.074) with a high negative radial velocity implying a lower galactic mass limit of 1.4×10^{12} $M_{\odot}$.

Reviews of the kinematical properties of globular clusters were given by Freeman (33.154.021, 33.154.026). Ninkovic (34.155.083) calculated orbital eccentricities of globular clusters. Innanen et al. (33.155.014) examine the shapes of typical globular cluster orbits. Lynden-Bell and Frenk (30.155.053) determine the circular velocity of the Galaxy (= 212 ± 16 km/s) from globular clusters. White and Frenk (33.154.028) discuss the kinematics of the globular cluster system. Lynden-Bell et al. (34.155.013) remeasured carbon stars in dwarf spheroidal galaxies and argue that the mass of the Galaxy is $2.6 - 10 \times 10^{11}$ $M_{\odot}$.

B. INTERSTELLAR MATTER

1. Central Regions

Reviews of the kinematic structure of the galactic center were presented by Oort (32.155.025, 32.155.073) and Townes et al. (33.155.022). Shklovskii (34.155.010) suggests that the kinematics and other features seen toward the galactic center can be explained by a supernova outburst in a massive binary ∿ 100 years ago. Rohlfs (34.155.070) shows that expanding features near the center can be explained either by large-scale expansion or by gas in closed orbits of approximately elliptical shape. Blitz et al. (29.155.005) proposed that the bending-wave theory of Bertin and Mark can provide the dynamical explanation of the tilt of the inner gas disk.

Becker and Sramek (32.141.053) made the first measurements of the proper motion of the compact non-thermal radio source at the galactic center by VLBI. Arguments for a massive black hole at the center were reviewed by Lacy et al. (32.155.038) and by Lacy (32.155.066). Brown (32.155.037) suggests that the radio continuum brightness distribution is due to collimated gaseous outflow along twin opposing beams. Lo and Claussen (34.155.059) identify three streams that could be due to infalling molecular gas. Hall et al. (32.133.005) present the discovery of a helium feature with a line width of ∿ 1500 km/s.

Lester et al. (30.132.012) detected the 63 μm line of OI toward Sgr A and find rotational and radial motions similar to ionized gas in the core of the Galaxy. Nadeau et al. (29.155.016) show that the spectra of Bγ toward the center has central velocities and line shapes similar to those reported for [NeII]. Bα and [NeII]

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lines were observed toward the center by Geballe et al. (32.133.022) showing evidence for ionized gas associated with IRC 16 and with $-500 < V < 450$ km/s. Bregman and Schwartz (32.156.004) present Westerbork data on the H110α recombination line toward Sgr A west. Caswell and Haynes (31.132.005) report the discovery of 3 HII regions near the center with high velocities.

Molecular gas at large negative velocities is detected in absorption against the galactic center by Linke et al. (29.155.013). Güsten and Downes (29.131.267) observed H_2CO and HI toward the galactic center and find weak high velocity absorption extending to $V = -210$ km/s. Güsten (32.131.323) summarizes detections of high-velocity gas toward the center and the observations and mapping of the central 15' in lines of NH_3 and H_2CO. CO observations of the inner 1° of the Galaxy are discussed by Inatani (32.131.289). Fukui et al. (34.131.299) detect molecular emission HCN which is shown to be in the central 10 pc of the Galaxy.

Cohen and Dent (34.155.041) make a large-scale survey of OH in the galactic center region which indicates a bar-like structure. Burton and Liszt (34.155.040) find an inclined CO feature in the quadrant where l, b are positive with a velocity gradient of $\sim$ 100 km/s over $\sim 1^{\circ}$ and with a large velocity dispersion. Sandqvist (32.131.324) observed H_2CO toward Sgr A west. The large-scale spatial and kinematic data for the overall system of molecular clouds at the center were reviewed by Scoville (29.131.129). Cohen and Few (29.131.010) made an H_2CO survey within a few degrees of the center and showed that the H_2CO is strongly concentrated toward the center.

HI observations from the central regions of the Galaxy were reported by Burton and Liszt (33.155.027). Rohlfs and Braunsfurth (32.155.012) investigate the kinematics of HI within 1.5° of the center. Quiroga (29.155.004) analyzed HI toward the center and finds systematic oscillating motions in the nucleus.

2. Galactic Rotation

Bok in his Russell Prize lecture (34.155.056) reviewed the recent progress made in unraveling the large-scale structure of the Milky Way and the determination of the outer Galaxy rotation curve. Knapp (33.155.053) reviewed determinations of the rotation law of the Galaxy. Schneider and Terzian (34.155.087) used radial velocities and a Σ-D relation for planetary nebulae to derive the rotation curve for $R > R_0$. Blitz (33.155.023) discusses the implications of a rising rotation curve on the mass distribution of the outer Galaxy. Blitz and Fich (33.155.046) examine the errors in the determination of the CO rotation curve for $R > R_0$. Gill and Shuter (34.155.058) made $\sin l - v$ plots in the first and fourth quadrants to analyze the HI kinematics and derive the rotation curve. Shuter (29.155.001) uses published 21 cm and CO data to reanalyze the rotation curve.

Ovenden et al. (33.155.040) and Pryce (33.155.041) examine the kinematics of stars and gas in the solar neighborhood. Shuter (33.155.042) uses a second-order Taylor series expansion for radial velocity to determine AR_0 from O and B stars and CO observations. Pismis (32.155.022) reviews the determination of the galactic rotation curve; Bektasova and Petrovskaya (34.155.019) and Petrovskaya (30.155.003) determine the rotation law from 21 cm profiles. Heiles (33.155.045) argues that motions of gas due to HI shells and supershells are the reason for much of the non-circular gas motions found toward the galactic anticenter. Yuan (33.155.036) discusses predictions of density-wave theory to argue that the LSR has a net motion with respect to young objects. Shuter (31.155.004) argues against the conventional LSR for studies of galactic rotation and suggests using a rotational standard of rest.

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3. Spiral Structure

Blitz et al. (33.155.115) and Blitz (34.155.037) use kinematics of the outer Galaxy to determine the properties of the HI disk beyond the solar circle. Turner (31.156.005, 31.156.021, 33.155.047) finds widely extended 1720 MHz OH emission and argues that it is a good tracer of spiral structure. Bash and Turek (33.132.038) compared l-v diagrams of HII regions and 1720 MHz OH emission and find that both suggest the presence of spiral arms. Gordon and Burton, however, (29.155.034) discuss the kinematics of molecular clouds and find the existence of clustering which is not satisfactorily explained solely by postulating spiral arms in the Milky Way. Clube (33.155.026) reports observations that may support the possibility that spiral arms are recurrently produced, short-lived material bodies.

Dolidze (33.155.069) tries to explain peculiarities of local spiral structure by the coexistence of leading and trailing arm systems of different power and development. Downes and Güsten (32.155.053) review investigations of large-scale galactic structure. Grinev (30.132.018) examines the kinematics of HII regions under the assumption of density waves in the Galaxy. Using three different kinematic models, Sawa et al. (33.155.071) show that the distribution and kinematics are consistent with the density-wave model and that the CO clouds form in spiral arms.

4. Disk and Solar Vicinity

Quiroga (33.155.112) examines the hierarchy of motions using the 21 cm line to study turbulence in the galactic disk. Lousto and Muzzio (33.155.033) use published photometric and spectroscopic results to show that turbulent motions in the Sagittarius arm which have been invoked to explain interstellar-line observations for $l > 340^{\circ}$ extend to $l < 340^{\circ}$ also. Schwartz et al. (31.155.051) present a Westerbork synthesis of the HI seen in absorption toward the galactic center. Pöppel et al. (32.155.024, 33.155.030) analyze HI profiles in Ophiuchus, Scorpius and Lupus. In a model of the local gas related to Gould's belt, Olano (32.155.008) considers the interaction between the expanding ring and the stationary gas.

De Graauw et al. (34.155.025) using their J = 2-1 CO survey of the southern galactic plane, measured the cloud-to-cloud velocity dispersion of the molecular gas. Liszt and Burton (33.131.125) examine the kinematics of CO in the inner Galaxy and find a velocity dispersion of 4.2 ± 0.5 km/s. Stark (33.131.124) uses the scale height of molecular clouds in the inner Galaxy as an indication of their kinematics. Liszt et al. (30.131.128) compare ^{13}CO terminal velocities with those of HI to show that the kinematics of dense molecular clouds are essentially the same as that of HI. Liszt and Burton (29.131.052) present synthetic l-v diagrams of CO for comparison with observations and include perturbations associated with galactic spiral structure. Liszt et al. (29.131.217) show that cold residual HI in molecular clouds is likely to be responsible for small-scale scatter in measured HI terminal velocities.

Lacey and Fall (34.155.006) examine the kinematic and chemical evolution of the galactic disk making detailed comparisons with observations. Bash (34.155.035) uses the ballistic particle model to predict what should be found in CO surveys of the southern galactic plane. Hilton and Bash (31.151.022) use the ballistic particle model to predict the velocities of young stars near the Sun and the vertex deviation toward $l = 320^{\circ}$.

5. Halo

Lockman (33.155.055) presents evidence that high z (> 500 pc) HI in the inner Galaxy shares in the rotation closer to the midplane. A complete set of radial ve-

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locities for all l, b for gas in a corotating and differentially rotating halo are presented by Feitzinger and Kreitschmann (32.155.005). McGee et al. (34.155.057) find low-intensity HI in the galactic halo in three distinct velocity ranges. A number of studies of high-velocity clouds have been made by Mirabel (29.131.252, 30.159.017, 31.132.022, 32.131.150). De Boer (33.131.128) reviews the progress in understanding the high-velocity component of the interstellar medium.

York (32.155.028) reviews data on gas in the halo including gas motions for comparison with quasar absorption lines. York et al. (34.131.194) observed SiIV absorption toward 3C273 which showed halo gas centered at zero velocity with no high-velocity components. De Boer and Savage (33.131.022) find an absorbing cloud toward M13 in an IUE spectrum and conclude that the cloud's motion is incompatible with halo gas corotating with the disk. York et al. (31.131.058) detect narrow interstellar absorption lines toward MK 509 and Fairall 9 that are consistent with a corotating halo.

VI. Dynamics

A. STELLAR ORBITS

1. Reviews

During the last years, work on stellar orbits concentrated on two areas: Firstly, the existence of non-classical integrals ("third integral") and the occurence of "stochastic orbits" has been investigated for various systems of two degrees of freedom (motions in the comoving meridional plane of axisymmetric galaxies and in the equatorial plane of spiral or barred galaxies). Secondly, three-dimensional orbits have been studied in detail for triaxial systems (galactic bars, prolate elliptical galaxies).

Reviews have been presented by Binney (32.151.041, 32.151.048) and by Contopoulos (34.151.103, 1984a). Many relevant papers can be found in the proceedings of IAU Symposium No. 100 (33.012.004). Relativistic stellar dynamics has been summarized by Contopoulos (34.151.034).

2. General Problems

Binney and Spergel (31.151.003, 37.151.008) developed a spectral description of orbits by using Fourier transforms and action integrals. Ratcliff et al. (37. 151.080) have applied this technique to two-dimensional orbits in triaxial systems. Carnevali and Santangelo (37.151.097) used the phase-space correlation function for determining the effective number of isolating integrals. Binney (32.151.034) discussed the applicability of Jeans's theorem.

The relation between the (infinite Feigenbaum-type) bifurcations of orbit families and the onset of stochasticity of orbits has been investigated by Contopoulos (1981, 34.151.011, 34.151.073, 1983a,b, 1984b).

General problems of non-classical integrals or stochastic behaviour of stellar orbits have been discussed by Antonov (31.151.045, 32.151.082), Barbanis (1984), Binney et al. (1984), Genkin and Genkina (32.066,013, 34.042.097, 1984), Gerhard (1984a,b), and Malasidze (30.151.089).

Orbital behaviour in systems of three degrees of freedom in general has been studied by Contopoulos et al. (32.151.087), Contopoulos (34.042.080), Magnenat (32. 151.064, 34.151.048), Martinet and Magnenat (29.151.039), and Martinet et al. (30. 021.015).

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Binney (30.151.002) studied the resonant excitation of motion perpendicular to galactic planes. Osipkov and his colleagues investigated numerically galactic orbits of various types of objects (30.153.009, 30.152.032, 30.153.035, 31.153,015). For relaxation of stellar orbits due to the irregular part of the galactic gravitational field, see Section VID3 of this report.

3. Spiral and Barred Galaxies

There is continuing interest in the behaviour of orbits in the equatorial plane of spiral or barred galaxies. Contopoulos (31.151.095) discussed the trapping of orbits around stable periodic orbits. Periodic orbits in barred galaxies have been investigated by Contopoulos (34.151.109), Petrou (33.151.045), and van Albada and Sanders (32.151.035). Regular and stochastic motion in barred or spiral galaxies has been studied by Athanassoula et al. (33.151.043, 34.151.040), Binney (32.151.033), Contopoulos (33.151.003), and Teuben and Sanders (33.151.044). The effect of resonances in barred galaxies is discussed by Contopoulos (30.151.040, 30.151.058), Martinet (37.151.020), and Papayannopoulos and Petrou (33.151.023).

A number of investigations aim at obtaining the response of a galactic disk to an imposed spiral, oval or barred perturbation of the potential from the studies of orbits. We mention Levinson and Roberts (29.151.058), Roberts et al. (33.151.031), Schwarz (29.151.090), Sanders et al. (33.151.047), Polzin and Thielheim (30.151.038), Spreckels and Thielheim (31.151.039), and Thielheim and Wolff (29.151.052, 31.151.011). See also Section VID of this report.

4. Oblate Ellipticals

Richstone studied orbits in oblate scale-free potentials (31.151.004) and used Schwarzschild's self-consistent field method to produce solutions to the collisionless Boltzmann and Poisson equations for oblate ellipticals (37.151.096); see also Miller (31.151.017). Other models for oblate spheroidal systems have been constructed by Petrou (33.151.014, 33.151.015) on the basis of an approximate third integral. Periodic orbits in elliptical galaxies have been investigated by Caranicolas (32.042.075, 34.151.033, 1984a,b), Caranicolas and Barbanis (32.151.046), Caranicolas and Maropoulou (34.151.059, 1984), Caranicolas and Varvoglis (1984), and Davoust (34.151.012).

5. Triaxial Systems

Schwarzschild and his coworkers (32.151.001, 33.151.132) have continued to study orbits in triaxial systems (prolate ellipticals or three-dimensional bars). Rotation has now been included (32.151.078). Special attention has been paid to the existence of semi-stochastic orbits with long evolution times (29.151.060). The collective stability of Schwarzschild's triaxial galaxy model has been studied by Smith and Miller (31.151.058).

Many other interesting investigations on stellar orbits in triaxial systems have been carried out. We mention here those by Caranicolas (37.151.037), de Zeeuw (37.151.003), de Zeeuw and Merritt (33.151.093), Magnenat (31.151.035), Magnenat and Martinet (33.151.057), Martinet and de Zeeuw (33.151.054), Mulder (33.151.090), Mulder and Hooimeyer (37.151.047), Pfenniger (37.151.068), and Wilkinson and James (31.151.012).

The orientation and kinematics of gaseous disks may provide clues concerning the true three-dimensional shape of triaxial systems. Such preferred orbital planes in triaxial systems have been studied by David et al. (34.151.090), Durisen et al. (33.151.005), Lake and Norman (34.151.001), Merritt and de Zeeuw (33.151.069), and Steiman-Cameron and Durisen (37.151.012).

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B. MODELS OF THE GALAXY

1. Basic Data for Constructing Galactic Mass Models

Reviews of implications of the recent observational data concerning the galactic structure were given by Bok (33.013.022) and Blitz et al. (33.155.115).

The recent data of the rotational velocity in the Galaxy were discussed by Blitz (33.155.023) and Knapp (33.155.053). A method to derive the circular velocity at the sun was proposed by Lynden-Bell and Frenk (30.155.053).

Analyzing the structure of the globular-cluster system, Frenk and White (31.155.001) estimated the distance of the Sun from the galactic center as $R_o \sim 6.8$ kpc, while Ovenden and Byl (33.155.039) reported that the direct analysis of the radial velocities of distant OB stars gives $R_o \sim 10.4$ kpc. From the local velocity field of stars, Shuter (33.155.042) derived again the IAU values of $2AR_o = 300$ km/s and $R_o = 10$ kpc.

Shuter et al. (33.155.040) discussed the velocity fields of gas and stars within five kpc of the sun. The local standard of rest was re-examined by Shuter (31.155.004) and Yuan (33.155.036). Oblak (34.111.001) analyzed the gradients of the velocity ellipsoid for the nearby stars.

Gilmore, Reid and Hewett (32.115.008, 32.115.009, 33.155.015, 34.155.118) have carried out an extensive photometric survey of low-luminous main-sequence stars with absolute magnitudes above the thermonuclear burning limit. They found a broad maximum near $M_V = +13$ in the luminosity function, and the total luminous mass density of about 0.04 $M_\odot/pc^3$ at the sun. They identified the old thin disk with the scale height of about 300 pc and a thick disk with the height of about 1500 pc, and excluded low-luminosity stars as candidates for the missing mass in the solar neighbourhood; see also the review paper 34.157.114, Gilmore (37.155.016), Reid and Gilmore (37.115.004), and Gilmore et al. (1984). Based on the data given by Gilmore and Reid , Edmunds and Phillipps (37.155.017) suggested that the galactic spheroid represents a major component of the Galaxy and may be equivalent to an elliptical galaxy with $M_V \sim -20$.

Bahcall et al. (33.155.012) evaluated the stellar content of the galactic spheroid, and fitted the galactic rotation curve with a four-component galactic

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