D. *The galactic halo*

Section IIIC of this report treats the progress made by optical techniques in problems of galactic structure at $|b| > 20°$. In the present section larger-scale phenomena revealed by radio observational techniques are of primary concern. Gehrz and Woolf (05.064.031) have deduced from infrared photometry the rates of mass loss from M stars, principally Mira variables. Then from prior data on the volume density of such stars they have calculated the rate of mass returned onto the galactic plane as of the order of 6×10^{-10} $M_{\odot}$ yr^{-1} pc^{-2}. When augmented by other halo and disk objects the total mass loss by stars is 7×10^{-10} $M_{\odot}$.

Several authors have considered the possibility of a radio halo. Razin (05.157.001) discussed Mathewson's polarization data, as well as the distribution of radio emission over the sky, and concluded that the local spurs and other features confuse the halo question considerably, but at least a strong halo is ruled out; a weak halo could exist. Clark *et al.* (04.157.011) from a study of low-frequency satellite and ground based observations from 0·5 to 100 MHz conclude that any halo contribution is below 15% of the overall brightness at 100 MHz, and the halo volume emissivity does not exceed 1% of the galactic disk emissivity. On the other hand, Abramjan *et al.* (03.157.022) derive models from observations in the range 96–150 MHz which require a relatively large radio halo in addition to the disk component.

The high-velocity gas will be considered in Section V B. There is some controversy over its distance and location in relation to the galactic structure.

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V. KINEMATICS

A. *Stars*

Galactic Rotation

A survey of stellar kinematics with its historical background and relation to stellar evolution has been given by Eggen (05.115.017). A comprehensive investigation of the structure and evolution of the Galaxy, involving radial velocity measurements in the polar caps for the determination of the z-attraction and detection of the tilt of the velocity ellipsoid outside the galactic plane has been proposed by Einasto and Kuzmin (04.155.021). Einasto (1971) has discussed available kinematical characteristics of subsystems of stars in the Galaxy, has derived mean values for the principal populations and has estimated the age of populations.

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On the basis of recent determinations of precession Fricke (05.043.005) has recommended that, for investigations in stellar motions, proper motions be corrected for errors in Newcomb's precession by adding the quantities

$\Delta(\mu_\alpha \cos\delta)'' = +0''.19 \cos\delta - 0''.44 \sin\alpha \sin\delta$,
$\Delta\mu_\delta'' = -0''.44 \cos\alpha$ to the centennial motions.

The discussion about the values of Oort's rotation constants A and B and of the velocity of rotation was perhaps livlier than in previous years. Mennessier (04.112.001; 05.112.001) investigated the accuracy of solar motion and galactic rotation as determined from proper motion data and the bias introduced by the hypothesis of secular parallax, and (07.043.002) proposed a Maximum Likelihood Method to determine these values. His method points to a value of A between 16 and 17 km s^{-1} kpc^{-1}. Similar questions were treated by Murray and Clube (04.112.024) and Clube (07.111.003). Clube (07.155.083; 1972) devised a technique to overcome the problem of handling high proper motions. He found disquieting results from a subdivision of the FK4 material into physically significant groups and concluded that possibly different values of A and B from those at present adopted must be reckoned with. The necessity of adopting improved values of the rotation constants was stressed by Bec (06.043.015). Filin (03.155.058) considered the influence of both random and systematic errors on the rotation constants. According to Crézé (04.155.024), A is underestimated by at least 1 km s^{-1} kpc^{-1} if the distances are affected by random errors.

The currently adopted value of the circular velocity of 250 km s^{-1} has been confirmed by Fricke (04.155.033). Toomre (07.155.084), assuming that it was the Large Magellanic Cloud that bent the disk of the Galaxy, has put that value into the range 185 to 220 km s^{-1}.

Solar motion and rotation constants have been determined from several types of observing material. Solar motion with respect to 268 well-resolved 21-cm hydrogen clouds is 21 km s^{-1} according to Mast and Goldstein (03.151.003). With respect to the local group of galaxies it is about 325 km s^{-1}, as derived by de Vaucouleurs and Peters (02.151.067). Vasilevskis and Klemola (06.043.001) attempted to determine the rotation constants from the Lick proper motions but concluded (06.155.013) that no reliable values can be obtained from the available fields. More accurate results can be expected after the Lick program has been completed. Fatchikhin (1972) has determined the solar apex and rotation constants from proper motions of 14600 stars, of magnitude 14·6 to 15·5, referred to galaxies. The Cepheids yield (Crézé 04.155.025) $A = 15{\cdot}5 \pm 1{\cdot}5$, (Wielen 1972) $A = +11{\cdot}5 \pm 5{\cdot}9$, $B = -7{\cdot}0 \pm 4{\cdot}7$ from proper motions and $A = +12{\cdot}9 \pm 4{\cdot}4$ from radial velocities. The supergiants give $A = +14$ according to Humphreys (03.155.011). Forty seven young population I planetary nebulae yield (Greig 05.155.011; 07.155.026) $A = 14{\cdot}5 \pm 0{\cdot}2$. Nearly one half of the local planetary nebulae were shown to move in circular orbits. Recent determinations of the solar motion and of rotation constants have been discussed by Schmidt-Kaler (05.155.029) with recommended values $A = 15{\cdot}1 \pm 0{\cdot}7$, $B = -11{\cdot}0 \pm 1{\cdot}3$. Van Schewick (06.153.020) obtained from proper motions of 61 galactic clusters a position of the solar apex which is similar to that of objects with small space velocities. According to Buscombe (1972), space velocities of 30 galactic clusters and their distances from multicolor photometry lead to $A = +16{\cdot}9$, $B = -4{\cdot}8$. A general discussion held at the Woolley Symposium has been concluded by M. Schmidt (07.155.085): "The constant A has been pretty stable since 1965. The value of B is quite uncertain as it depends on proper motions of local objects, a derivation criticized by Clube. The value of $-B/A$ from the velocity ellipsoid may be as high as 1. I see no strong objection to Toomre's preferred value of $R_0 = 8$ kpc". Fricke (1973), on the other hand, pointed out that both fundamental proper motions and those measured with respect to galaxies are in good agreement in the value of constant B but differ in the case of A.

The rotation curve derived by Georgelin and Georgelin (04.155.005) from H II regions is in a very good agreement with the Schmidt curve, while Simonson and Mader (07.155.057) find from neutral hydrogen observations in the region $0{\cdot}2 < R < 5$ kpc values up to 15% above Schmidt's curve. A comparison of rotation curves in the galactic plane and 100 pc above and below it has led Quiroga and Varsavsky (03.155.074) to the discovery of some peculiarities in the rotation curve. Observed waves in the rotation curves were interpreted as population effects by Pişmiş (1973).

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An interpretation of the K-effect as a result of dust screening of the stars from the side of their apex motion has been offered by Arshinova and Radzievsky (05.155.004). Loss of mass energy from the Galaxy, whether by gravitational radiation or otherwise, should cause the Galaxy to expand according to Sciama *et al.* (02.151.054). This view is opposed by Jordan (03.155.066).

Velocity distribution

Maksumov (03.151.059) has shown that the distribution of peculiar velocities must be nonisotropic. Shatsova (05.151.003) studied the distribution in the phase space starting from an empirical Planck distribution of stellar velocities.

There are strong indications that the vertex deviation is related to spiral structure. Mayor (03.155.021) gave an explanation of observed anomalies in the plane velocity distributions in terms of spiral density waves. The same author also discussed the more plausible interpretations of the vertex deviation (initial conditions or non-axisymmetrical perturbation of the potential). The kinematic consequences of a corotating local perturbation, i.e. the Orion arm, were also considered (Mayor 07.155.028).

The technique of finding stellar velocities has been sketched by Woolley (06.155.046) and a remark on the transformation of radial and tangential velocities into the galactic system has been made by Hill (01.112.008). Gotska (Malysheva) (01.112.011) investigated the influence of distance errors on the dispersion of radial velocities.

Star streams play an important role in the kinematics of nearby stars. The Local Group was studied by Froeschlé (02.151.068), the Ursa Major stream and the Hyades by Ogorodnikov and Latyshev (04.155.037; 06.152.007), the Scorpio-Centaurus association and Gould's Belt by D. H. P. Jones (05.152.008) and Glaspey (1972), the Arcturus group and four smaller groups by Eggen (05.155.055 and .056). The phenomenon of moving pairs among nearby A-stars has been shown to be real by Lü and Upgren (1972). Maeder and Martinet (1972) obtained a kinematic age for the subgroup Upper Scorpius in Scorpio-Centaurus in agreement with a new determination of the nuclear age.

Critical remarks on selecting high-velocity OB stars according to space velocities were made by Pavlovskaya (02.112.014). High-velocity A dwarfs and G-K giants of population II have been found by Fehrenbach *et al.* (04.112.001) in projection on the Large Magellanic Cloud. Early type high-velocity stars have been investigated by Vitrichenko (02.112.015), horizontal-branch population II stars by Philip (03.112.003), four-color photometry of 200 southern high-velocity stars has been reported by MacConnell (04.113.035). A number of high-velocity stars has been found among southern B-stars by Hill (06.112.001), three early G-type high-velocity stars have been observed by Bond (04.112.008), and a high-velocity B star, BD $+6°2461$, has been discussed by Berger *et al.* (06.112.004).

A general survey of the motions of nearby stars has been made and their statistics given by Woolley (05.115.033) and by Woolley *et al.* (06.155.007). Their velocity distribution has been reviewed by van de Kamp (06.155.008).

The motions of supergiant stars are shared by the gas, and shearing motions appear between the sides of the spiral arm, as expected from Lin's theory, according to Humphreys (03.155.011; 03.155.054; 05.155.003; 07.155.012; 07.151.071; 1972). Courtès *et al.* (02.155.008) have found that the interstellar matter and young stars have the same kinematic characteristics which indicates the predominance of gravitational forces. This has been confirmed by Moore (07.155.043) who has found that stars and gas appear to move together at nearly zero relative velocity. Also, Abt *et al.* (04.119.003) have made a study of the motions of single stars and binaries in the Perseus arm and have concluded that the mean radial velocity of single stars (and probably the binaries also) is similar to that of the neutral hydrogen in their vicinity.

Somewhat different results have been reported by Minn and Greenberg (1972) from comparisons between the radial velocity distributions of H I, H II regions, open clusters, and O associations in the outer parts of the Galaxy. They find a difference between H I and stars, and also between the velocities of H II regions and their associated stellar objects. They conclude that stars rotate faster

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than gas in the part of the galactic disk outside the solar circle, and more slowly in the inner part. In earlier studies, Mezger *et al.* (03.155.015) and Georgelin (04.131.014) found good agreement between radio and optical observations of HI and HII motions. Harrison (06.155.005) suggests that the gaseous component in the disk has an outward radial drift velocity relative to the stellar component.

Rohlfs (07.155.022) gives a discussion of the density-wave theory from a local viewpoint, in particular a possible variation of Oort's constant and local streaming motions.

The B stars form a non-steady group in the z-direction according to Jõeveer (01.151.009). Their velocity ellipsoid and rotation constants were determined by Filin (03.155.059). The velocity distribution of O- and B-type stars has been studied by Mirzoyan and Mnatsakanian (03.112.013) with regard to their expansion from parent associations. Their velocity dispersion of 13 to 14 km s^{-1} has been determined by Shatsova (03.112.012; 1970). Artiukhina (03.152.015) studied vertical motions of early type stars and variable stars in the Orion region. The kinematics of early-type stars has been discussed by Thackeray (07.155.082).

The motions of A stars are very important for the determination of the attraction perpendicular to the galactic plane (see Section VI). Their motions at the North Galactic Pole have been studied by Eggen (02.112.020). A significant increase in the velocity dispersion with height above the galactic plane has been reported by Woolley *et al.* (02.112.019) and by Harding *et al.* (06.155.027). The same effect has been reported by Blaauw *et al.* (07.155.054) for metal rich stars of intermediate galactic population. The solar motion of Ap stars has been studied by Day (02.151.062) who found that they are kinematically similar to late B stars.

The kinematics of local early F stars show, according to Rydgren (03.155.002), that a local concentration of these stars is real. Martinet (04.112.012) studied the relation between the space motions and the rotation speed of nearby F stars. Powell (07.115.002) studied the ages and kinematics of the late F dwarfs and found an agreement with Fowler's exponential galactic nucleosynthesis hypothesis. The dispersion in velocities of G stars near the North Galactic Pole was studied by Sturch and Sharpless (07.114.097). Gomez and Jaschek (05.155.058) compared the solar motion and velocity ellipsoid of giants and dwarfs. A correlation between the CN anomaly and velocity dispersion of G and K giants has been studied by Janes and McClure (05.113.025) and by Yoss and Lutz (06.112.010). Space motions for bright southern K and M giants were derived by Eggen and Stokes (04.113.002) and for some red giants of the old disk population by Eggen (06.113.032).

A large number of K-type dwarfs was investigated by Eggen (05.115.004) and their solar motion and velocity ellipsoid by Upgren (07.112.002). He (1972) also studied variations of the K3-M2 main sequence with space motion. Murray and Sanduleak (07.112.013) suggest on the basis of proper motions of faint M dwarfs that these stars are numerous and contribute significantly to the mass density in the solar neighborhood. This was confirmed by B. F. Jones (1972) in the region of the Pleiades.

Gliese (05.126.018) calculated the solar motion from the space velocities of 17 white dwarfs and found that the axes of the velocity ellipsoid are essentially the same as for M-type dwarfs.

The motions of the more evolved and metal-richer visual binaries differ from those of the solar-type stars according to Bakos (1973).

Among variable stars, the kinematics of cepheids has been discussed by Geyer (03.122.056), Takase (04.122.038), Crézé (04.155.025) and Wielen (1972). The last author found that the average motion of cepheids in the galactic plane does not differ significantly from the adopted circular velocity. Barnes (07.122.028) redetermined the solar motion, galactic rotation and velocity ellipsoid for Mira variables as functions of their period. Their kinematical properties were also studied by Gotska (04.122.104). Feast *et al.* (1972) have found no significant evidence for a dependence of a mean kinematic property on the period of semiregular red variables. They have determined the solar motion and velocity dispersion from 200 stars. Aslan (05.111.010) has investigated space velocities of RR Lyrae type variables, in particular the influence of the estimate of their distances. Delta Scuti stars were studied by Frolov (1972).

The motions of planetary nebulae were studied and the solar motion derived by Deutsch and

Orlova (05.133.025). Isobe (07.155.004) finds that the large z-motions of some galactic clusters are explained by systematic errors of proper motions. Zhukov (07.154.012) has determined space velocities of the globular clusters M3 and M5.

B. *Interstellar matter*

Galactic rotation – Non circular motions

A review of the state of motion of the interstellar matter as revealed by radio-astronomical observations has been made by Kerr (05.155.032). Wentzel (07.131.086) has discussed forces acting on interstellar gas, including cosmic rays, shock waves and a large-scale ordered magnetic field. He finds two main features, large-scale order as well as turbulence. Chiao and Wickramasinghe (1972) have found that dust grains, which carry a net electric charge, may be driven out of the galactic disk, or out of the Galaxy, along magnetic field lines by radiation pressure of starlight. This process could control the distribution and lifetime of dust within the galactic disk.

The basic model of the local gas system associated with Gould's belt is that of a spherical shell of gas expanding under the influence of galactic differential rotation. There are differences in the parameters of the shell derived by various authors (Harten 07.155.091; Hughes and Routledge 07.131.074; Knapp 1972; Lindblad 1972; Mast 1972), but all are in approximate agreement on the initial expansion velocity, 4–6 km s^{-1}, and the age, $6–7 \times 10^7$ yr.

In the analysis of 21-cm survey data, the emphasis has shifted in recent years to the importance of kinematic effects on the profiles, whose shapes are very sensitive to velocity variations (Burton 07.155.061; 1972; Tuve and Lundsager 1972). In the absence of saturation, irregularities in the velocity field are themselves sufficient to produce the structure in the profiles which has generally been interpreted in terms of density concentrations, when galactic structure maps are derived assuming purely circular rotation. To exploit this fact, Burton (07.155.061) assumed for illustrative reasons that *all* structure in the profiles has a kinematic origin. The resulting profiles are consistent with gas motions observed in several regions and with motions predicted by the density-wave theory.

The streaming motions predicted by density-wave kinematics have been demonstrated most clearly by Burton (05.155.001) for hydrogen in the Sagittarius arm and by Humphreys (1972) for stars in the Carina arm. The best evidence in support of the density-wave theory at the present time, however, comes from studies of external galaxies.

Hobbs (05.131.092), Mast (1972) and Goniadzki (07.131.053) find good agreement between radial velocities of optical and radio interstellar lines. Rickard (05.155.050; 1972) has begun observations of radial velocites of interstellar lines in the spectra of southern OB stars with a view to studying systematic motions of the gas. A preliminary analysis indicates a net flow of 18 km s^{-1} in the gas outward from the galactic center in the Sagittarius spiral feature. Venugopal (04.155.010) finds the same solar motion from two groups of H I concentrations which have different velocities. Rolling motions of interstellar gas were found by Fujimoto and Tanahashi (05.155.014 and .015) and interpreted as a consequence of free precession of the Galaxy. Another interpretation, as a result of the bending of the galactic plane has been proposed by Yuan and Wallace (1972). Tumbling and shearing motions within spiral arms are indicated by a systematic tilt of the spiral arm features (Harten 07.155.091). Greenberg and Minn (07.131.033) studied kinematics of dark clouds and concluded that several of the larger clouds seem to be associated with spiral arms. Galactic winds have been discussed by Johnson and Axford (05.151.025) and by Matthews and Baker (06.151.046).

Central region

Oort (06.155.017) gave a review of the composition and activity of the nucleus of our Galaxy and its comparison with M 31. Petrovskaya (05.155.042) studied the rotation curve in the central region both in and outside the galactic plane.

Several authors have reported evidence for expanding rings of gas in the nuclear region. A high-velocity H I survey made by Sanders *et al.* (07.155.003) brought further evidence for explosive events in the galactic nucleus. Sanders and Wrixon (07.155.027) find a continuation to negative longitudes

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of the large feature discovered by van der Kruit, suggesting thus a complete rotating and expanding ring of hydrogen about 2·4 kpc from the center. A ring of 270 pc radius, expanding with a velocity of 130 km s^{-1} and rotating with a velocity of 50 km s^{-1} has been suggested by Kaifu *et al.* (1972). A similar model has been proposed by Scoville (1972), based on observation of molecular clouds.

Sanders *et al.* (07.155.087) have discussed the 3-kpc arm as the most important expanding feature in the Galaxy. Their model leads to an oscillatory phenomenon in which the arm is alternately moving outwards and inwards on a time scale of order 10^7 yr.

As an alternative to expansion, Simonson and Mader (07.155.057) describe a model in which the material in the inner rings is all moving in stable gravitational orbits and the 3 kpc arm is regarded as a dispersion ring at the inner Lindblad resonance. The apparent expansion is then the outward component of motion in part of an elongated orbit, and high-energy explosions are no longer needed. Most of the remaining gas is then rotating in a large nuclear disk.

The explosive events and their interpretation as such are supported by some theoretical considerations. Spiegel (03.155.050) considered a model of a quasi-steady circulation. A hydromagnetic wind from the nucleus reaches the 3 kpc arm, where a shock front is formed; then the gas moves out of the plane and eventually returns to the nucleus. Gurtu (04.151.046 and .047) has presented a far reaching theory in which the explosion of the nucleus is responsible for the spiral structure and for the separation of the Magellanic Clouds from the Galaxy. Rood and Welch (05.155.021) discussed the key factors for the formation of the halo, one of the possibilities being violent ejection from the galactic nucleus. An outward radial drift of the gas was studied by Harrison (06.155.005) and extensive hydrodynamical calculations of explosions have been made by Sanders and Prendergast (07.151.016). General dynamics and the X-ray and optical radiation associated with a massive object moving supersonically through a galaxy were studied by Saslaw and de Young (07.151.069). The results, however, of the recent analysis of the motions of the neutral hydrogen by Simonson and Mader (07.155.057) seem to make it unnecessary to invoke activity in the galactic nucleus to account for the expanding motions.

Basu and Roy (07.155.029) have discussed a density-wave model for the inner parts of the Galaxy. They support the dispersion-ring interpretation of the 3-kpc arm, stating that the observed radial flow pattern in the central region is required for the region to sustain itself against gravitational instability in the disk. The model is stated to give a satisfactory explanation of the observed velocity distribution.

Closer to the center, Sandqvist (06.155.050; 1972) has used lunar occultation observations to find a rotational motion inside the strongly-absorbing cloud of molecules centered on $+40$ km s^{-1}. Gardner and Whiteoak (07.155.030) report that their H_2CO observations of the positional change with velocity are consistent with a rotation in the galactic plane but are not conclusive.

High velocity clouds

The high-velocity hydrogen is being treated in this separate subsection because there is controversy over its distance and location.

Several extensive new surveys have been published in the triennium under review. Meng and Kraus (03.131.102) found four principal groups of high-velocity clouds and various other individual clouds and concluded from their data that the high- and intermediate-velocity clouds seem to be associated. Rickard (05.131.017) surveyed a limited part of the sky at high declinations. Van Kuilenburg (07.157.001 and .005) covered the whole sky visible from Dwingeloo, finding a very strong preference for negative velocities, and no correlation between the high-velocity clouds and other large-scale features. Dieter (05.131.056; 07.157.002) has studied the region $b = -15°$ to $+15°$, $l = 10°$ to $250°$ at high sensitivity, and (07.131.056) later extended the survey to the section $|b| > 15°$. She showed that high-velocity gas is very prevalent near the galactic plane, with no clear cloud-like structure. Wannier *et al.* (07.157.008) concentrated on declinations as far south as they could reach from Holmdel, New Jersey. In very-high-sensitivity observations, they showed that a considerable amount of positive-velocity hydrogen exists at southern declinations.

Hulsbosch (06.131.033) has listed 31 early-type stars which are seen in projection against some low-latitude high-velocity clouds. These stars are useful for estimating cloud distances from the interstellar absorption lines. Kerr and Knapp (07.131.132) have looked for high-velocity hydrogen in the direction of six globular clusters whose spectra show high-velocity interstellar calcium lines. Partial correlation was obtained, indicating that at least some of the hydrogen is closer than 10 kpc.

Various suggestions have been made in the past for the location of the high-velocity gas, from infalling intergalactic gas, now at about 100 pc, to the extreme of extragalactic distances. Venugopal (04.155.010) concluded from solar motion solutions that the high-velocity gas is related to the Galaxy. Dieter (05.131.056) showed that both the maximum velocity and the amount of the high-velocity gas observed are functions of galactic coordinates. She developed a model in which the material is in the outer part of the Galaxy, widely-spread in the z-direction, and moving with a combination of rotation and infall. Davies (07.155.038) and Verschuur (07.155.015) have each made further observations and have independently suggested that the high-velocity hydrogen is in outer spiral arms of the Galaxy, extending to large z-distances above and below the galactic plane.

Similar z-extensions of spiral arms were first discussed by Kepner (03.155.019) for more limited regions. Hulsbosch and Oort (1972) have suggested that the proposed relationship of high-velocity hydrogen to vertically-extended spiral arms does not rule out an intergalactic origin for the gas, as accreting material would tend to enter the Galaxy through the spiral arms.

De Vaucouleurs and Peters (02.151.067) made solutions for the solar motion with respect to the high-velocity clouds which suggest that the clouds are close satellites of the Galaxy. Kerr and Sullivan (02.131.049) find that the clouds are at a distance of the order of 50 kpc. Verschuur (05.131.083) observed and discussed intermediate-velocity clouds and proposed a model for their existence. The discovery (Verschuur *et al.* 07.131.095) of very small-scale velocity and angular structure in high-velocity clouds might considerably change the estimates of parameters of these clouds.

Assuming that high-velocity high-latitude hydrogen clouds are intergalactic matter falling towards the galactic plane, Larson (1972) proposed to explain the deviations from circular orbits by the dynamical pressure of infalling matter. The accretion of matter may be responsible for the spiral structure and the activity of the nucleus.

High velocity clouds of neutral hydrogen have been discovered in the central region of the Andromeda galaxy by Whitehurst and Roberts (1972).

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VI. DYNAMICS

A. *Stellar orbits – third integral*

Basic statistical and physical assumptions of stellar dynamics have been considered by Tsitsin (02.151.005). Other general aspects have been discussed and reviews of stellar dynamics given by Idlis (02.151.006), Contopoulos (05.151.034; 06.151.039), Rudnicki (02.151.058; 03.151.017), and Kuzmin (03.151.008).

The general problem of angular momentum and rotation and their origin has been treated by Peebles (01.151.004), Hunter (04.151.024 and .034), and Harrison (06.151.011). Brosche (05.158.098) has found a correlation between the maximum rotational velocity and the type of the Galaxy. Thus, the Hubble sequence at constant mass can be interpreted as an angular momentum sequence. Noonan (06.158.023), however, announces negative results of an attempt to find a correlation between the radius of maximum rotational velocity of spiral galaxies and other galaxian parameters.

No equipartition is possible in galactic nuclei according to Spitzer (02.151.038) and Saslaw and de Young (06.151.049).

Supposing that the phase density depends on three isolating integrals, Agekian (05.151.015) has derived the equations of motion in a self-gravitating non-spherical stellar system. He also (Agekian 06.151.022; 07.151.022; 1972) derived an analytical form of the third integral supposing that the density depends on the integral of energy and integral of areas only, and assuming that box-orbits appear. Stodókiewicz (1972) has considered potentials with the third integral quadratic in velocities and has found a class of potentials more general then that of Stäckel type, having such an integral for at least one family of orbits. The relation between the stability of circular orbits and the torus-like volumes accessible to stars in three-dimensional orbits was studied by Malasidze (1972) in steady-state systems with an axis and a plane of symmetry.

Deprit and Henrard (03.151.024) have stressed the fact that for practical purposes, stellar dynamics is justified in pretending that Contopoulos' model is structured by the third integral, even though it is likely that the model is not separable.

An initial perturbation as a cause of strong coupling of R- and z-motions in the outer parts of the Galaxy has been proposed by Innanen (02.151.016). Pomagaev (04.151.041) has solved the equations of motion of low-velocity stars taking into account unstable spiral perturbations. The series of papers on orbits in highly perturbed dynamical systems by Contopoulos (05.151.012) has been continued with a discussion of non-periodic orbits. In such cases there are many orbits asymptotic to two different periodic orbits. On the other hand, it was found that even with large perturbations small tubes of quasi-periodic orbits persist. It is doubtful whether real ergodicity is ever attained in dynamical systems, even locally.

Keplerian orbital parameters of O and B type stars have been computed by Ampel (04.155.043) and of galactic clusters by Syrovoj (03.151.066; 05.155.047). An expression for the potential which allows one to obtain plane galactic orbits in terms of elliptic functions has been discussed by Kuzmin and Malasidze (05.151.006). Malasidze (06.151.007) tackled the interesting question of dependence of the elements of plane galactic orbits on the structural parameters of the potential. Statistics of galactic orbits in terms of the history of the Galaxy has been presented by Woolley (06.155.046).