model has yet emerged. One would wish for more reliable data pertaining to galactic gradients, the IMF, and other observable features which might form the basis for a unique model. The thick disk has been confirmed by several, independent observations. Its structure and its dynamical properties will be subject of continuing discussions. The precise nature of objects near the galactic centre is still a controversial topic, on which new observations are needed. Observations planned for the Hubble Space Telescope promise considerable advances in all aspects of stellar studies in our Galaxy.

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6. Large-Scale Aspects of the Distribution of Interstellar Matter

6.1 General

The previous report on structure and dynamics of the galactic system was given by Wielen (41.155.100). The recently recommended values for solar distance to the galactic center (8.5 kpc) and our rotation speed around it (220 km.s^{-1}) were discussed by Trimble (42.155.043).

The distance scale of the Galaxy was reviewed by Barkhatova *et al.* (40.155.088). A discussion of typical corrugation scales in the Galaxy was given by Spicker and Feitsinger (42.155.003), who concluded that three distinct scales seem to exist: 1–2 kpc, 4–8 kpc, and > 13 kpc. These corrugations are reflected in the distribution of O and B-stars and HII regions, and to a lesser extent in the HI distribution. Feitsinger and Spicker (39.155.026) investigated the corrugation phenomenon for the (heliocentric) longitude range $10° \leq l \leq 240°$ as derived from HI studies.

The proceedings of the 106th IAU Symposium : "The Milky Way Galaxy", were edited by van Woerden, Allen and Burton (39.012.007).

6.2 Observations and their Interpretations

6.2.1 Neutral Hydrogen

An HI survey of the southern Milky Way for $240° \leq l \leq 350°$ and $|b| \leq 10°$ using the 18-m Parkes antenna, was presented by Kerr *et al.* (42.155.040). The HPBW is 48′, and the velocity resolution is 2.1 km.s^{-1}.

The Leiden-Green Bank survey of atomic hydrogen was published by Burton (40.155.056) and Burton and te Lintel Hekkert (40.155.057). Observations with the *NRAO* 140-foot telescope cover the complete longitude range accessible at $\delta > -46°$ and the latitude interval $|b| \leq 20°$. The sampling interval is 1° in both l and b. The kinematic resolution is 1 km.s^{-1}. The observations are displayed as cross sections through the data cube in longitude, velocity coordinates at constant latitudes, and as cross sections in latitude, velocity coordinates at constant longitudes. Maps of integrated velocity intervals, and of HI column densities are also presented. Burton and te Lintel Hekkert (39.155.024) discuss the HI survey north of $\delta = -40°$ in the latitude range $|b| \leq 20°$. An atlas of cuts through the galactocentric data cube of HI observations at constant R-values in Θ, z coordinates, at constant Θ-values in R, Θ coordinates was published by Burton and te Lintel Hekkert (42.155.025). Maps of the galactic arrangement in R, Θ coordinates of projected HI surface densities, z-height of the gas-layers centroids, maximum volume density, as well as measures of the layer thickness are presented.

Pöppel and Viera (40.155.060) published an HI survey of the region $240° \leq l \leq 359°, +3° \leq b \leq +17°$ with a velocity resolution of 2 km.s^{-1} and an extent from -100 km.s^{-1} to $+100$ km.s^{-1}. The l and b separation was 1°. The region $-3° \leq l \leq 21°$ and $-4° \leq b \leq +3°$ was surveyed with the Effelsberg 100-m telescope by Braunsfurth and Rohlfs (38.131.009). The velocity range was -300 km.s^{-1} $\leq v_{lrs} \leq +300$ km.s^{-1}, with sampling intervals of 0.1 and 2 km.s^{-1}. The sensitivity was about 0.5K. An HI survey in the region $120° \leq l \leq 142°$ and $-5° \leq b \leq +5°$

with the Effelsberg 100-m telescope was presented by Braunsfurth and Reif (38.155.059). The velocity range of this survey was -180 km.s$^{-1} \leq v_{lrs} \leq +80$ km.s^{-1}, and the sensitivity was about 0.3 K.

HI observations made by Olano (40.131.094) of the region $290° \leq l \leq 320°$ and $+3° \leq b \leq +17°$ reveal the presence of HI features with filamentary characterisctics, and a close correlation of radio-continuum emission and HI gas at large height above the galactic plane. A discussion of the vertical distribution of galactic HI was given by Bania and Lockman (39.155.025), based on data from the Arecibo-Green Bank survey.

Dickey and Garwood (42.155.053) used the *VLA* to measure 21-cm absorption in directions with $|b| < 1°, |l| < 25°$ to probe the cool atomic gas in the inner Galaxy. Most of the absorbing gas is associated with molecular cloud complexes. A 21-cm study of 9 areas that have the smallest known amount of HI in the northern hemisphere was carried out by Lockman *et al.* (41.131.137). The data indicate that the HI column density never drops significantly below 4.5×10^{19} cm^{-2} anywhere in the sky. Observations of HI profiles in 34 directions in the region $(172° \leq l \leq 97°)$ at high galactic latitude and in 59 directions towards the LMC were published by McGee and Newton (42.131.311). Using the HI column densities as references, depletions in the abundances of calcium and sodium in the halo, spiral arms and the LMC disk were estimated.

Lockman *et al.* (41.131.103) mapped the extent of the local HI halo. The principal result is that the total column density of HI at $|z| > 1$ kpc is, on the average, $5 \pm 3 \times 10^{19}$ cm^{-2}, or 15 % of the total N_{HI}. The HI halo in the inner Galaxy was discussed by Lockman (38.155.027). There is 21-cm emission from corotating HI in the inner Galaxy to $|z| \geq 1000$ pc from the plane. Over most of the inner Galaxy more than 10% of the HI emission at the subcentral points comes from $|z| > 500$ pc. High-z HI is not present ≤ 3 kpc from the galactic center, but appears suddenly near R = 3.5 kpc.

Heiles (38.155.014) used combined existing HI surveys to derive lists of new shell-like objects that cross survey boundaries at $b = 10°$. Spatial filtering revealed wormlike structures in the inner Galaxy. Sodroski *et al.* (39.131.-040) studied the structure and kinematics of the HI associated with Gould's Belt, using data of high velocity resolution and large latitude extent $(10° \leq l \leq 350°)$.

Observations in the 21 cm line made with the *NRAO* 43-m telescope of 20 randomly selected intermediate and high-galactic-latitude regions were published by Jahoda *et al.* (39.131.119). The data were examined for evidence of the neutral-gas clumping which is required by models in which a substantial fraction of the diffuse soft X-ray background originates outside the galactic disk and is absorbed by interstellar gas. No such evidence was found. Shull and van Steenberg (40.131.042) presented high resolution (0.1 Å) spectra obtained with the *IUE* satellite. From these spectra, HI column densities toward 244 early-type stars were derived.

The kinematics and distribution of HI in the Galaxy was reviewed by Petrovskaya (40.155.080). Topics like non-circular motions and the application of the wave-theory of spiral structure to investigations of HI in the Galaxy were treated. The large-scale distribution of HI in the Galaxy was discussed by Petrovskaya (41.155.094). The distribution of atomic hydrogen and diffuse gas in the Galaxy was discussed by Heiles (41.155.103).

Feitzinger and Spicker (39.155.148) showed on the basis of recently published HI data and new radial velocity fields that the so-called rolling motion phenomenon is only partly explained by geometric effects. An improved method and a new warp model to correct the observed velocity gradients for these apparent rolling motions were used. The HI at the outer edge of the Galaxy was discussed by Jackson (39.155.027).

An investigation of small-scale HI structure at high galactic latitude was made by Jahoda *et al.* (38.131.274). The number density and random motions of interstellar HI clouds have been studied by Anantharaimaiah *et al.* (41.131.-241) and (38.131.072) using a method which involves comparison of thermal velocities of HI absorption spectra in the direction of HII regions with their recombination line velocities. Using HI data, Kulkarni and Fich (39.155.084) find that a detectable amount of higher than normal velocity dispersion HI exists. The "fast" HI probably constitues of $\leq 20\%$ of the total mass of galactic HI, but contains most of the kinetic energy of the ISM.

Results of 21 cm HI observations in the region $220° \leq l \leq 260°, |b| \leq 15°$ with the *RATAN*-600 radio telescope were presented by Yudaeva (40.155.079). Observations were made at constant declination scans on right ascension with 5° steps in declination. The results are shown as antenna temperature $(\alpha - v_{lrs})$ maps of gas distribution in the vicinity of the outer spiral arm of the Galaxy.

Mirabel and Morras (39.131.044) reported the results of a search for high-velocity hydrogen around the direction of the galactic center. About 2000 positions were surveyed with the 43-m *NRAO* telescope with an *rms* of 0.03 K on a velocity interval of $-1000 \leq v \leq +1000$ km.s^{-1}. A deep Dwingeloo survey for high-velocity clouds was reported by Hulsbosch (39.131.043). Preliminary results were presented for $0° \leq l \leq 200°, -70° \leq b \leq +70°$.

6.2.2 Carbon Monoxide

The Massachusetts-Stony Brook galactic plane CO ($J = 1 \rightarrow 0$) survey was discussed in several publications. Clemens (41.155.090) presented the observations, and gave some discussion on galactic structure, and of cloud identification. The (b, v) maps of the first galactic quadrant were given by Sanders *et al.* (41.155.001). The data from the *FCRAO* 14-m telescope consists of 40,551 spectra in the longitude range $8° \leq l \leq 90°$ and $-1°.05 \leq b \leq +1°.05$. The spectral coverage was 300 km.s^{-1} at 1 km.s^{-1}. The small grid spacing enables detection of all clouds larger than $\sim$ 15 pc diameter in the $R = 0.4 - 0.8R_o$ molecular cloud ring. The (l, v) maps were given by Clemens (41.155.002) in (l, v) format as seven gray-scale maps, and in (l, b) format as 17 contour- and gray-scale maps of integrated CO intensity. The presentations are useful for comparison with other first-quadrant surveys. The disk and spiral-arm molecular cloud population derived from the survey was discussed by Solomon *et al.* (39.155.112). Molecular clouds and cloud components in the inner Galaxy with a size larger than 10 pc could be detected. The total number of emission centers is seen to be distributed as 75% cold molecular cores in the disk, and 25% warm molecular cores in the spiral arms.

Determination of the dependence of CO radial velocity on galactic longitude along loci of tangent points in the inner Galaxy was made by Clemens (40.155.016). The measurements were combined with published data for HI in the nuclear region, outer Galaxy CO–HII regions, and globular clusters, to yield a rotation curve. Rivolo *et al.* (41.155.035) discussed the statistical clustering properties of the $\sim$ 2000 molecular cloud cores that were identified in the survey between $20° \leq l \leq 50°$. Evidence was presented that the warmest cores are strongly clustered into groups with a characteristic size of $\sim 50 - 150$ pc.

The Columbia CO survey of molecular clouds in the galactic quadrant was announced by Cohen *et al.* (39.155.-029), and published by Cohen *et al.* (41.131.141) The galactic disk was surveyed from $12° \leq l \leq 60°$ and $|b| \leq 1°$ with a sampling of 0°.125 for $|b| \leq 1°$, and 0°.25 elsewhere. The entire collection of spectra as well as spatial and (l, v) maps were presented.

Maps of ^{12}CO emission in the first galactic quadrant were published by Knapp *et al.* (39.155.058). Their survey consists of strip maps in latitude at 38 galactic longitudes ($4° \leq l \leq 90°$), spaced at equal intervals of sin l. The latitude sampling is 2′. The velocity resolution is 0.65 or 2.6 km.s^{-1}. The data are presented as (l, v) maps, as latitude-averaged maps, and as a latitude-averaged (v, sin l) map.

A CO ($J = 2 \rightarrow 1$) survey of the southern Milky Way was discussed by van der Stadt *et al.* (39.155.031). The survey consisted of three parts: the galactic plane ($b = 0°$) in the range $270° \leq l \leq 355°$, 88 dark clouds with and without associated nebulosity, and 47 bright HII-region complexes.

A latitude survey of CO ($J = 1 \rightarrow 0$) emission near the galactic center was presented by Bania (39.155.032, 42.155.044). The region surveyed covered $350° \leq l \leq 25°$ at latitude points $b = 0', \pm 10'$ and $\pm 20'$. The bulk of the ^{12}CO emission in the inner Galaxy could be produced by three massive objects: the nuclear disk/bar, the "3 kpc arm", and the "+135 km.s^{-1} feature". A wide latitude CO survey of molecular clouds in the northern Milky Way was made by Dame and Thaddeus (38.131.268). The area $12° \leq l \leq 100°$ and $-5° \leq b \leq +6°$ was fully sampled with the Columbia 1.2-meter telescope.

A wide-latitude CO survey of molecular clouds in the third quadrant was published by May *et al.* (40.131.293). The region surveyed was $180° \leq l \leq 280°$ and $|b| \leq 5°$, at a angular resolution 0°.5. Distances and masses of more that 30 molecular clouds related to the Perseus arm and Cygnus arm were calculated. McCutcheaon *et al.* (39.155.030) discussed the distribution of CO in the southern Milky Way from a survey of the ($J = 1 \rightarrow 0$) line in the area $294° \leq l \leq 358°$ and $-0°.075 \leq b \leq +0°.075$ with a sampling interval of 3′. Robinson *et al.* (38.155.032) presented the distribution of CO ($J = 1 \rightarrow 0$) for the longitude interval $294° \leq l \leq 86°$. A global average radial distribution of molecular gas out to R_o was derived.

The distribution of ^{13}CO in the inner galactic plane was discussed by Liszt *et al.* (38.155.055). The longitude range was $20°.5 \leq l \leq 40°.0$. The emissivity ratio of ^{12}CO over ^{13}CO, the cloud mean free path and cloud-cloud random velocity dispersion, and the effect of cold HI in molecular clouds on 21-cm HI profiles were discussed.

CO ($1 \rightarrow 0$) and CS ($2 \rightarrow 1$) observations of the neutral disk around the galactic center were presented by Serabyn *et al.* (42.155.034). A $2' \times 6'$ region at the center of the Galaxy was mapped in CO with a 21″ resolution using the *IRAM* 30-meter telescope. Additional spectra were measured in the CS line. The observations are consistent with an inclined disk orbiting about the galactic center in an almost circular orbit. Harris *et al.* (40.155.009) mapped the central 10 pc of the Galaxy in the CO ($J = 7 \rightarrow 6$) line. The emission comes from a dense clumpy disk of temperature 300 K. Possible heating mechanisms were discussed. The data show that the rotational velocities drop by a factor of 1.4 to 2 between 2 and 6 pc from the center.

The merits of HI and CO observations as tracers of spiral structure were discussed by Kerr (41.155.072). Individual structural features are often easier to identify in CO. Robinson *et al.* (41.155.019) presented a geometrical

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framework provided by CO and HI observations of six directions where gas is seen tangentially along a spiral feature, and four directions where extended structures cross the $R = R_o$ circle.

A comparative analysis of ^{13}CO with ^{12}CO and HI emission in the galactic plane was made by Xiang (41.131.313). Statistics indicate that most peaks of ^{13}CO integrated emission anticorrelate with the corresponding HI integrated intensities.

6.2.3 Sub-millimeter and Infrared

A survey of the galactic plane in the first quadrant ($-5° \leq l \leq +62°$) at wavelengths 150, 250, and 300 μm with a $10' \times 10'$ beam, was published by Hauser *et al.* (38.155.046). The emission detected arises mostly from sources known to have 5 GHz or CO emission. A total of 80 prominent discrete sources were identified and characterized. Campbell *et al.* (38.155.030) presented a far-infrared and submillimeter survey of the the galactic plane ($11°.5 \leq l \leq 17°.5$) with $11'$ resolution at wavelengths of 93 μm, 154 μm, and 190 μm. The maps were interpreted in terms of the temperature and spatial structure of diffuse far-infrared and submillimeter sources associated with evolved HII regions and a continuous ridge of galactic emission.

Caux and Serra (42.155.023) reported galactic disk observations ($-150° \leq l \leq 82°$) at $\lambda_{eff} = 380$ μm made with the *AGLAE* 83 balloon-borne instrument. The longitude profile exhibits diffuse emission all along the disc with bright peaks associated with resolved sources. A far-infrared (FIR) survey of the galactic disc ($250° \leq l \leq 20°$) in the southern hemisphere was presented by Caux *et al.* (38.155.012). The observations were made with a baloon-borne instrument in the wavelength range $114 - 196$ μm. The FIR emission could be due to very large complexes of HII regions, giant molecular clouds, and lower density gas, which are distributed along galactic spiral arms. The complete data set of this survey, presented in the form of brightness contour maps, was published by Caux *et al.* (39.133.003). A comparison was made with the radio continuum data at 5 GHz.

Campbell *et al.* (39.155.106) presented a far-infrared and submillimeter survey of the galactic center and nearby galactic plane in the range $359° \leq l \leq 5°$. The data were obtained with a balloon-borne telescope from channels filtered for a bandpass of $70\ \mu\mathrm{m} \leq \lambda \leq 110\ \mu\mathrm{m}$ and for a longpass of $\lambda < 80\ \mu$m. Continuous emission was mapped along the galactic plane, and discussed in detail.

Mid-infrared observations at 4, 11, 20, and 27 μm of the galactic center region were discussed by Little and Price (40.155.007). The diffuse emission around the galactic center can be separated into three components: foreground emission from the 4–5 kpc ring, a spheroidal component surrounding the center, and an elliptical component immediately surrounding the galactic center. Catchpole *et al.* (39.155.014) presented infrared scanning observations of the galactic bulge. Interstellar absorption was derived from J, H, and K bands of a $7' \times 200'$ strip of the sky from Sgr I to the galactic center. The visual absorption (excluding dark clouds) ranges from 3 to 30 mag. in that region.

The large-scale mapping of the Galaxy by *IRAS* was discussed by Gautier and Hauser (39.155.036). The high sensitivity of the *IRAS* instrument for detection of interstellar matter in the survey mode was illustrated in terms of visual extinction and dust and gas column densities.

Tereby and Fich (42.131.308) found a strong, apparently linear correlation between the IR cirrus at 100 or 60 μm and HI near the galactic plane. *IRAS* sky brightness images were compared with the Weaver-Williams HI survey in two regions near $l = 125°$ and $l = 215°$. The dust temperature inferred is nearly uniform, and in reasonable agreement with theoretical predictions.

6.2.4 Molecular Clouds

The large scale distribution of molecular clouds as a function of galactic radius and azimuth was discussed by Scoville *et al.* (38.155.006). Particular emphasize was given to the 5–8 kpc molecular cloud ring and to the issue of CO spiral structure. A summary of properties of the emission regions was provided.

The number and distribution of molecular clouds in the inner Galaxy was discussed by Thaddeus and Dame (38.155.007). Two CO (l, v) diagrams, covering of much of the first and second quadrants, are given. Huang and Thaddeus (42.131.307) carried out a CO survey toward every confirmed outer Galaxy supernova remnant in the range $70° \leq l \leq 210°$, and found that half of them revealed spatial coincidence with large moleculer cloud complexes.

A comparison of CO (2.6 mm), HII ($H100\alpha$: 6 cm), and far-infrared (150 μm, 250 μm) surveys over $-1° \leq b \leq +1°$ and $12° \leq l \leq 60°$ was published by Myers *et al.* (41.131.105). Some 54 molecular cloud complexes with mean mass of 10^6 $M_\odot$ were identified. The estimated star formation efficiency for the entire sample lies near 0.02.

An estimate of the radial distribution of molecular hydrogen from star formation rates was given by Rana and Wilkinson (41.155.009). The derivation was made independently of the CO surveys, and a comparison is made with the controversial estimates of Σ_{H_2} based on various CO surveys.

Gatley *et al.* (42.155.029) presented the first detailed maps of the surface brightness and velocity field made in the ($\nu = 1 \rightarrow 0$ $S(1)$) line of molecular hydrogen, with a spatial resolution of 18″ and a velocity resolution of 130 km.s^{-1}. The molecular ring that surrounds the nucleus of the Galaxy was confirmed to be tilted $\sim 20°$ out of the plane of the Galaxy. Detailed far-infrared observations of several atomic and ionic fine-structure lines and molecular rotational lines toward the galactic center were discussed by Genzel *et al.* (40.155.050). The dominant motion of the observed neutral gas disk is rotation about an axis similar to the rotation axis of the Galaxy. The dynamics of interstellar clouds in the galactic center as determined by the nuclear mass distribution was also examined.

A CO survey of high-latitude molecular gas was carried out by Magnani *et al.* (40.155.015). About 57 clouds were found in 35 complexes at $|b| \leq 25°$. The clouds are distributed asymmetricaly with respect to $b = 0°$; the distribution is consistent with a displacement of the sun of 30 pc above midplane.

The face-on distribution of molecular gas in the first quadrant, derived from the Massachusetts-Stony Brook galactic plane CO survey, was compared to the galactic distribution of giant HII regions by Clemens *et al.* (42.155.055). The HII regions were found to preferentially select gas regions of higher than average density, and showed a strong correlation with the second power of the gas density. Burton *et al.* (40.131.292) gave a preliminary analysis of the distribution of dust in the Galaxy and a comparison of the dust distribution with that of the gaseous components.

The distribution of CH in the Galaxy was investigated by Johansson (39.155.034). Observations with 2°.5 spacing in the range ($10° \leq l \leq 60°$) and ($310° \leq l \leq 350°$) were made in the main-line transition in the $^2\pi_{1/2}, J = 1/2$ ground state Λ-doublet at 3335 MHz. Maurice *et al.* (39.131.035) studied absorption lines of interstellar sodium, covering a substantial part of the Galaxy at high spectral resolution.

A survey of the galactic center region in the CS ($J = 2 \rightarrow 1$) line was published by Stark *et al.* (42.155.051). Güsten *et al.* (42.155.052) reported 88 GHz observations of HCN ($J = 1 \rightarrow 0$) emission and absorption in the central 5 pc of the Galaxy.

6.2.5 Radio Continuum

A complete VLA survey in the outer Galaxy was published by Fich (42.155.057). All continuum sources stronger than 0.3 Jy at 21 cm, smaller than 2′, and in the area defined by $93° \leq l \leq 163°, -4° \leq b \leq +4°$ were observed at 6 cm with a resolution of 4″ and a sensitivity of 1 mJy. The unresolved objects were also observed at 2 cm with the same resolution and sensitivity. The purpose of the study was to identify objects within the disk of the outer Galaxy. Beuermann (40.155.054) presented a three dimensional model of the galactic radio emission at 408 MHz, based on the all-sky survey of Haslam *et al.* In this model, the Galaxy consists of a thick non-thermal radio disk in which a thin disk is embedded. Both disks exhibit spiral structure. The thick disk emits about 90% of the total power at 408 MHz.

The first part of a survey of the southern sky at 2.3 GHz was presented by Jonas *et al.* (40.155.026). The surveyed area was $-63° \leq \delta \leq -24°$, $12^h00 \leq \alpha \leq 22^h00$. The angular resolution was 20′, the sensitivity better than 16 mK.

Reich *et al.* (38.155.057) presented a radio continuum survey at 11 cm for the area $357°.4 \leq l \leq 76°$, $-1°.5 \leq b \leq +1°.5$. The angular resolution is about 4′.3, and the sensitivity is 20 mJy/beam area. A catalogue of 1212 small-diameter radio sources was compiled. A very deep survey of the Galaxy at 7.6 cm was published by Berlin *et al.* (38.155.020).

A description of recent surveys of galactic continuum radiation was given by Reich (40.155.022). The surveys dicussed include the Bonn 408 MHz all-sky survey, the Bonn 1420 MHz survey which will be extended by observations with the Argentinian 30-m dish, the Effelsberg 1420 MHz and 4875 MHz surveys, and the Effelsberg 2695 MHz survey.

6.2.6 Kinematics and Spiral Structure

The Milky Way halo gas kinematics were discussed by Danly (42.155.054). A distinction was made between higher column density material in the form of condensed clouds, and low column density diffuse material.

Feitzinger and Spicker (42.155.007) investigated the vertical velocity asymmetries observed in HI spiral arms, the so-called rolling motion phenomenon. A descriptive energy model of spiral arm regions with pronounced vertical velocity gradients, so-called VAR's (Velocity Active Regions) was presented, and compared with the energetics of star forming regions. The spiral structure of the Galaxy for the region $38° \leq l \leq 70°$ was discussed by Jacq *et al.* (40.155.081). The Bordeaux ^{13}CO survey and the Arecibo HI survey have been used to explain most of the features observed in the (l, v) diagrams, and consequences of small kinematical deviations from the mean rotation curve on the shapes of predicted spirals in the (l, v) plane were examined.

The galactic nucleus was reviewed by Oort (39.155.051). The mini-spiral and the possibility of a central black hole were discussed, as were the supernova remnants, HII regions, molecular clouds and other phenomena in the central region. Possible expanding features, the asymmetry and low rotation of the bulk of the molecular gas, and the tilt of the gas layer were reviewed.

Liszt (39.155.046) considered some results of attempts to trace the spiral structure in HII regions, HI, and CO. Deriving galactic structure in CO seems to be recapitulating the history laid down by HI observers.

A model of a two dimensional quasi-steady solution of the gas-dynamical equations in the gravitational potential of a weakly barred galaxy was presented by Mulder and Liem (41.155.031). From the solution, (l, v) diagrams were constructed and compared with HI observations in our Galaxy. Gorbatskij and Usovich (42.131.036) presented results of computations that show that ringlike structures consisting of clouds must be formed in spiral galaxies due to viscosity. The origin of GMCs is discussed.

6.2.7 Rotation Curve

Gerhard and Vietri (42.155.046) showed that the narrow peak ($v_{max} \simeq$ 250–260 km.s^{-1} at $r \simeq$ 500 pc) and the steep decline for 600 pc $\leq r \leq$ 1.5 kpc down to a rather broad minimum ($v_{min} \simeq$ 195 km.s^{-1}) around 2.8 kpc as seen in the rotation curve as inferred from HI and CO terminal velocities, can be reconciled with the bulge distribution determined by infrared observations and the local density of spheroid stars only if the bulge of our Galaxy is non-axisymmetric and the resulting potential triaxial.

A determination of the galactic rotation curve from selected HII regions was made by Rohlfs *et al.* (41.155.036). For $R < R_\circ$ the rotation curve relies mainly on radio data, and in the innermost 4 kpc non-circular gas motion was taken into account. For $R > R_\circ$ the curve is based on HII region data. The resulting rotation curve is flat on a large scale.

The rotation curve up to 16 kpc was determined by Kolesnik and Yurevich (39.155.195) using the relation between parameters of OH molecular features of clouds and the distance to the clouds. From the position of the central peak in the rotation curve, the sun's galactocentric distance was estimated to be $\sim$ 8.5 kpc. The mass of the Galaxy interior to 100 kpc from the galactic center is $\sim 3 \times 10^{12}$ $\mathcal{M}_\odot$, as was derived from the rotational velocity distribution.

Haud (38.155.024) discussed the rotation curve of the Galaxy for $R > R_\circ$. It was argued that the apparent rise of rotational velocity in the outer regions of the Galaxy may be the result of a too-simple method of processing the observational data. It was also shown that the wavy form of the rotation curve may be evoked by the spiral density waves in the Galaxy.

The rotation curve of the Galaxy in the distance range $1 < R/R_\circ \leq 1.6$ was derived by a method which utilizes the whole HI 21-cm line profile by Petrovskaya and Teerikorpi (42.155.002). No evidence was found for a fall-off below a flat rotation curve in the distance range covered by the method. The rotation curve of the outer parts of the Galaxy was determined by Petrovskaya and Teerikorpi (41.155.102) from neutral hydrogen 21-cm line profiles.

A graphic way of presenting the HI data and determining the galactocentric distance R/R_0 in the method of Agekyan *et al.* (1964) was introduced by Teerikorpi (40.155.075).

Brand (*"The Velocity Field of the Outer Galaxy"*, Ph.D. Thesis, Leiden, 1986) analyzed photometric and CO data of Nebulous objects in the outer Galaxy, and calculated the rotation curve. He finds that $R_\circ = 8 \pm 0.5$ kpc, for a flat rotation curve and $\Theta_\circ$ = 220 km.s^{-1}. Part of this work has already been published (Brand, Blitz, & Wouterloot, *Astr. Astrophys. Suppl.* **65**, 537; Brand, Blitz, Wouterloot, & Kerr, *Astr. Astrophys. Suppl.* **68**, 1; **69**, 343).

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7. Galactic X- and Gamma-Radiation, Magnetic Fields and Pulsars

7.1 Diffuse Galactic X-ray Emission

The past triennium saw considerable activity on the interpretation of the diffuse X-ray background. Marshall and Clark (38.142.091) analyzed the *SAS-3* survey of the soft X-ray sky in the *C*-band (~0.1 – 0.28 keV) and concluded that the counting rates in this band and HI column densities are generally anticorrelated down to the angular resolution of their detector (~ 3°). They showed that the data can be fitted by a two-component model: a local hot plasma and a galactic halo extending beyond most of the absorbing clouds. Knude (39.131.186) has modeled such a scenario. Burrows *et al.* (38.155.081) studied the Wisconsin survey and HI observations of sky areas near the galactic poles and concluded that most of the observed X-ray flux must originate on the near side of the most distant neutral gas. In any case, the observed anticorrelation is weaker than expected if the obscuration would be due to a uniform absorbing layer. Jacobsen and Kahn (42.142.034) showed that this weakness of the anticorrelations can be understood if the absorbing material is highly clumped. Jahoda *et al.* (39.131.119; 42.131.436) searched for evidence of this clumping, studying HI column density variations at medium- and high-latitude regions to 10′ resolution. No such evidence was found.

Hirth *et al.* (40.131.219) found high-negative-velocity HI clouds in close positional coincidence with enhancements in the soft X-ray surveys. They suggested that the X-rays are caused by conversion of the collective motion of the high-velocity clouds into thermal energy during a deceleration process in the ambient gas.

Rocchia *et al.* (37.131.007) performed spectral observations of the soft X-ray background and detected CV, CVI, and OVII lines, which confirms the temperature of about 10^6 K of the hot medium in the solar vicinity. They found evidence for a weak component at a higher temperature which, they suggested, could be produced by a hot halo. Bloch *et al.* (42.142.018) reported the results of very soft X-ray observations (Be band, ~ 0.078 – 0.111 keV) of a section of the northern galactic hemisphere; the rates are consistent with the expectations from a plasma of $\sim 10^6$ K.

Kahn and Caillault (41.142.090) combined several *EINSTEIN* IPC fields and found an excess of diffuse M-band emission (0.1 –2 keV) at low latitudes which exhibits a resolved, double-peaked profile that is roughly symmetric about $b = 0°$ with a half-width of $\sim 1° - 2°$. A similar galactic ridge (without the absorption dip) was found at higher energies and was recently mapped by *EXOSAT* (40.155.037). Modelling of the *EINSTEIN* and *EXOSAT* data indicates that the scale height of the emitting region is of the order of 100 – 200 pc and that the radial scale length is roughly 5 kpc. The physical origin of the emission is uncertain – it is probably at least partly due to discrete sources. Several possibilities have been considered (40.155.037; 41.142.090; 40.142.064; 42.131.434). Koyama *et al.* (41.155.042) reported the detection of an intense emission feature in the emission along the galactic ridge at about 6.7 keV attributed to iron.

7.2 Diffuse Galactic Gamma-Ray Emission

No new γ-ray experiments that are of direct interest for studies of the structure of our Galaxy were flown during the last three years. There are, however, interesting new developments in the studies of low-energy γ-ray lines being detected from the general direction of the galactic centre and in studies of very high energy γ-rays (> 1000 GeV), which are reported elsewhere in this volume. Most of the new results that are relevant for this report were obtained from analyses of the *COS-B* data base (~ 50 MeV – 5 GeV) which became publicly available in 1985. Discussions of the diffuse galactic γ-ray emission at lower energies (~ 1 – 30 MeV), using balloon observations, are given by Sacher and Schönfelder (37.143.039) and Lavigne *et al.* (42.143.017). Two text books on γ-ray astronomy, by Hillier (38.003.026) and Ramana Murthy & Wolfendale (41.003.030) appeared.

The galactic γ-ray emission in the *COS-B* energy range seems to originate largely from cosmic-ray/matter interactions (through π^0-decay and bremsstrahlung). Dermer (41.143.005) reconsidered the production of π^0-mesons in these interactions using accelerator data. Bloemen (39.131.128) re-evaluated the γ-ray contribution of a weak third component, namely the inverse-Compton emission originating from the interaction of cosmic-ray (CR) electrons with the interstellar photon field.

Significant progress in the interpretation of the *COS-B* data could be made mainly because large-scale CO surveys of the Galaxy became available, particularly the one by the Columbia group (Dame *et al.* 1987, *Ap. J.* **322**, 706). These have been used together with various HI surveys in γ-ray /gas correlation studies, which gave insight in the galacto-centric distribution of CR particles, the CO-H_2 conversion factor (on a galactic scale as well as for some local molecular clouds), and the amount of molecular gas in the Galaxy. Several authors presented these type of analyses, although with various different approaches: Bloemen *et al.* (37.155.072; 38.143.012; 41.155.003), Harding & Stecker

(39.155.101), and the Durham group (37.143.013; 38.143.025; 38.144.045; 39.155.091; 42.155.059; 39.143.061; Bhat *et al.* 1987, *J. Phys. G*, **10**, 1087; Mayer *et al.* 1987, *Astron. Astrophys.* **180**, 73). There are discrepancies between the results, but these can to a large extent be understood and the findings are converging in recent work. The main conclusions that can be drawn are that the radial CR gradient in the Galaxy is very weak (a radial exponential scale length of roughly 10 – 15 kpc), the ratio $N(H_2)/W_{CO}$ is $< 3 \times 10^{20}$ mol.cm^{-2}.K^{-1}.km^{-1}.s and thus near the lower edge of independent prevous estimates, and the H_2 mass inside the solar circle is $\lesssim 1.0 \times 10^9$ $\mathcal{M}_\odot$.

Blitz *et al.* (39.143.022) found that the γ-ray flux from the central few hundred parsecs of the Galaxy is nearly an order of magnitude smaller than the value expected from the H_2 masses generally estimated to be present in the center and from the γ-ray emissivity measured for the galactic disk.

Pollock *et al.* (39.143.040; 40.143.093) searched for γ-ray excesses in the *COS-B* data which cannot be explained by the predicted γ-ray emission from HI and CO observations (with a smooth CR distribution). They found indeed some point-like γ-ray sources which do not have counterparts in the gas data and which may be due to localised enhancements of the CR density or, alternatively, genuine point sources.

Strong (39.131.089), Strong *et al.* (40.143.088), and Lebrun and Paul (40.143.086) continued their studies of the observed γ-ray emission at intermediate latitudes using galaxy counts as a gas tracer. Lebrun and Paul showed that the well-known discrepancy between the observations and predictions toward the inner Galaxy at medium latitudes (the observed intensities are larger than expected) is larger than found previously. This is the result of an improvement in the calibration of the galaxy counts after an observational bias was detected (Lebrun 1986, *Ap. J.* **306**, 16). Lebrun and Paul (40.143.086) and Bhat *et al.* (1985, *Nature* **314**, 515) suggested that this excess may be attributed to Loop I. Bloemen *et al.* (1987, *Astron. Astrophys.*, in press) suggested recently that it may originate from CR-matter interactions in the ionized medium with a large scale height, as traced by pulsar Dispersion-Measure data (which was not taken into account in the model).

Bloemen (1987, *Astrophys. J. Lett.* **317**, L15) and Bloemen *et al.* (1987, *Astron. Astrophys.*, in press) used the high-energy part of the *COS-B* data base to study CR spectral variations throughout the Galaxy. They found that the γ-ray spectrum shows a flattening with increasing latitude toward the outer Galaxy. This effect is not seen toward the inner Galaxy. They compared their findings with similar results from a recent study of the galactic radio-continuum emission at 408 and 1420 MHz (summarized in the following section) and conclude that significant CR spectral variations exist in the Galaxy. They argued that this spectral behaviour can be explained by the galactic-wind model of cosmic-ray propagation proposed by Lerche and Schlickeiser (31.063.020; 32.143.056), but some other possibilities cannot be excluded.

7.3 Magnetic Fields

Two text books on magnetic fields in astrophysics, including discussions on galactic fields, appeared in this triennium (Bochkarev - 39.003.047; Seymour - 42.003.061). Sofue *et al.* (42.157.056) published a review of the global structure of magnetic fields in galaxies. Heiles (1987) gave an extensive overview of interstellar magnetic fields and Zweibel (1987) reviewed the theoretical aspects (both in *Interstellar processes*, eds. Hollenbach & Thronson, Reidel, Dordrecht).

The relationship between the interstellar magnetic field strength and the gas density is still poorly understood. Troland and Heiles (41.131.100) presented a compilation of observations. The field strengths show no clear evidence of increase for $n = 0.1 - \sim 100$ cm^{-3}. At higher densities, a modest increase in field strength is observed in some regions. Several new measurements of the Zeeman splitting of OH lines were presented (42.131.025; 41.131.286; 41.131.098). Aperture synthesis observations of the 21-cm Zeeman effect toward Cas A (41.131.098) indicate considerable spatial structure of the magnetic-field strength; peaks often coincide with clumps of molecular gas. In general, the findings are not inconsistent with theoretical expectations for selfgravitating clouds, but questions still exist about how the magnetic field strength remains rather constant for densities up to ~ 100 cm^{-3}.

Vallée and collaborators continued their analyses of interstellar "magnetic bubbles" with sizes of 100 – 300 pc (37.131.179) and found a relation between the observed magnetic field strength in a shell and the degree of compression of the shell (39.131.300). Simonetti *et al.* (38.155.037) used rotation measures of extragalactic sources to investigate variations in the interstellar magnetic field on length scales of $\sim 0.01 - 100$ pc.

There is increasing observational evidence that the field is often morphologically related to the interstellar gas, e.g. parallel or perpendicular to filaments, and systematically oriented in large shells (38.131.134; 38.131.098; Heiles 1987). Theoretical aspects of these phenomena in clouds and the implications for star formation are discussed by Mestel and Paris (38.131.011). Several studies of the role of magnetic fields in star formation have been carried out, but these are reported elsewhere in this volume.

Wielebinski (39.141.024) discussed the available radio-continuum surveys of the sky and presented the likely survey developments in the future. Beuermann *et al.* (40.155.054) constructed a three-dimensional model of the radio emission at 408 MHz based on the all-sky survey of Haslam *et al.* (31.141.036). In this model, the Galaxy consists of a thick (several kpc) non-thermal disk and a thin disk which contributes only about 10% to the total power at 408 MHz. The authors suggested that the magnetic field and relativistic particles in the thick disk are dynamically coupled to the hot halo gas. Reich and Reich (41.141.002) have completed the Stockert 1420 MHz continuum survey of the northern sky and used this map and the 408 MHz survey of Haslam *et al.* to calculate a spectral-index map of the northern sky (Reich and Reich 1987a, *Astron. Astrophys. Suppl.*, in press). This map shows a flattening of the spectra with increasing latitude, particularly toward the outer Galaxy. At lower frequencies, the spectra show, if any large-scale variation, a steepening with increasing latitude (Lawson *et al.* 1987 reviewed these observations – *Mon. Not. R. Astron. Soc.* **225**, 307). The comparison with gamma-ray observations was discussed in the previous section.

Seymour (41.155.027) considered the coupling between the dynamics of the interstellar gas and the galactic magnetic field. Several authors have reanalysed the role of magnetic fields and cosmic rays in the (quasi) hydrostatic equilibrium and stability of the galactic disk (40.144.021; 40.144.207; 41.131.264; Bloemen 1987). Chernoff *et al.* (41.155.096) studied the stability of the galactic magnetic field in the presence of a magnetic monopole halo. Kulsrud (42.155.104) argued that the wind-up problem of the magnetic field of the Galaxy can be solved and that a primordial origin of the galactic field is therefore possible.

7.4 Pulsars

This section reports on statistical studies of the galactic pulsar population and on the impacts of pulsar observations on studies of the ISM. Taylor and Stinebring (42.126.009) and Radhakrishnan (42.126.010) reviewed the developments of pulsar research. Stokes *et al.* (40.126.027; 42.126.078) and Clifton and Lyne (41.126.019) presented the results of recent pulsar surveys at Green Bank, Arecibo, and Jodrell Bank, which extend the presently known sample to over 440 pulsars.

Studies of the galactic distribution of pulsars indicate a scale height of about 400 pc and a smooth increase of the number density toward the galactic centre (Guseinov and Yusifov - 39.126.050; Lyne *et al.* - 39.126.038). Including in this work the 32 new pulsars discovered by Clifton and Lyne (41.126.019) shows convincingly that the pulsar density falls within about 5 kpc (Clifton, priv.comm.).

Allakhverdiyev *et al.* (40.126.021) and Trimble (40.125.105) discussed the connection between the distribution of pulsars and SN remnants. Amnuel *et al.* (41.126.017) studied the proper motions of a pulsar sample and concluded that the birthplaces of pulsars are located within OB-associations and/or in spiral arms. Blaauw (40.126.067) evaluated the local evaporation of massive stars during the past 50 Myr and showed that the estimated evaporation may well account for the local replenishment of pulsars. The author argued that the high space velocities of pulsars cannot be explained as runaway velocities of the progenitors due to binary disintegration following a SN explosion, contrary to the conclusion reached by Radhakrishnan and Shukre (41.126.005). Chevalier and Emmering (41.126.058) modeled the observed properties of pulsars and used their model to calculate the variation of pulsar number, period, and characteristic time with z. Huang *et al.* (40.126.042) studied these parameters for the two types of pulsars they proposed in earlier work.

Using dispersion measures and independent distance estimates for a subset of pulsars, Lyne *et al.* (39.126.038) estimated the electron density distribution in the Galaxy (within several kpc from the Sun). They found that the electron density model that is most consistent with the data consists of a layer of much greater scale height than that of the pulsars (with a density of ~ 0.03 cm^{-3} at $z = 0$) and a thin layer with $n(0) \simeq 0.015$ cm^{-3} and a scale height of $\sim$70 pc, both components having a weak density increase toward the galactic centre. Several studies on fine scale electron density fluctuations in the ISM have been reported during the past few years, using measurements of scintillations and temporal broadening of pulsar signals (and angular broadening of galactic and extragalactic sources) (37.131.182; 37.131.190; 37.131.251; 38.131.162; 39.126.040; 39.131.292; 42.131.052; 39.131.265; 42.131.376; 42.131.128; 41.131.182).

8. Galactic Kinematics

8.1 Stars

A substantial body of new radial velocity and proper motion measurements have been made during the past triennium.

8.1.1 Radial Velocities

Radial velocities for standard stars have been obtained for standard stars by at least three groups (41.111.010, 39.111.040, 39.111.044). The *CORAVEL* spectrometers have been an important instrument for these as well as many of the studies mentioned here. The southern sky has also been the target of several extensive surveys (40.111.001, 39.111.002, 38.111.009, 42.111.019, 39.111.036, Preprint 1). Measurements of particular spectral types have been as follows: OB stars including those in clusters and proposed runaways (41.111.020, 39.111.022, 40.155.047), F dwarfs (39.155.153), K0 stars (41.111.003), and RR Lyraes (40.111.008). Other classes include barium stars (37.111.019, 39.111.030), Mira variables (Preprint 2), blue horizontal branch field stars (39.111.001, 41.111.004), high proper motion subdwarfs (41.111.016), population II stars (39.111.032) and stars in globular clusters (41.154.019, 37.154.047, 42.111.003). Mayor reports that the *CORAVEL* spectrometers have already made 25,000 measurements of 10,000 stars for the *HIPPARCOS* mission (40.111.010), and preliminary results of a survey of O–F8 stars within 15° of the North Galactic Pole was also published (39.111.045).

8.1.2 Proper Motions

The following proper motion studies were published during the past triennium: Pleiades-Hyades region stars (39.111.025), R Coronae Borealis stars (39.111.017), stars within 20° of the South Galactic Pole to 17 mag (42.111.014, 42.111.015), dwarf K and M stars (42.111.007), halo stars (39.155.152), and selected areas of the Pulkovo zone (39.111.055). Many regions and stellar types were extensively investigated, with several studies containing ~ 5000 stars.

8.1.3 The Disk

In the following two sections we report studies which are primarily analytic in nature which make extensive use of previously published measurements. Early type stars were the subject of several kinematic investigations which investigated the O star velocity ellipsoid (37.111.002), kinematics as a function of age (38.155.063), corrections to the precession constant (38.111.025) and the motions of open clusters (39.155.016). Brosche and Schwan (38.111.019) present evidence for a breaking wave in the velocity field of nearby young stars. Palous has low values of the Oort *A* constant from analysis of B and A stars (40.111.011), and Balasz argues that the kinematics of A stars may be the result of periodic star formation with a characteristic time that is near a galactic rotation time (37.155.100).

The solar motion and velocity ellipsoid has been the subject of several new studies (39.111.014, 37.155.041, 39.155.082, 41.155.113, Bassino, *et al.*) stellar velocity dispersions from the Yale bright star catalogue were derived (39.155.164), and a random walk analysis has been made to investigate the effect of giant molecular clouds on stellar velocity dispersions (37.151.061). Phase mixing in the distribution of stars was investigated by Fuchs (38.151.110), and Clube (39.155.017) reanalyzed the concept of star streams first proposed by Kapteyn.

Other kinematic studies investigate constraints on the past star formation history of the Milky Way (39.155.144), evolutionary phases of peculiar red giants (39.155.162), relativistic and perspective effects in radial velocity and proper motion measurements (41.111.001), the linkage of solar neighbourhood kinematics to large-scale galactic structure (42.155.027), and the old stellar population (39.155.012). *IRAS* sources in the bulge are argued to be Mira variables by Feast. Allen, *et al.* (Preprint 3) study an unusual nearby wide binary which they argue has an apogalacticon of 115 kpc.

8.1.4 The Halo

An important study of halo kinematics was published by Ratnatunga and Freeman (39.155.100) who found that the outer halo is, at most, slowly rotating and that the line of sight velocity dispersion is independent of distance from the Sun. From the velocity dispersion of carbon stars at the north galactic pole, Mould, *et al.* (39.111.012) find a higher velocity dispersion than predicted from the Ratnatunga and Freeman model which was modeled by White

(40.155.010) with a spherical potential and flat rotation curve. The density and abundances of halo stars were measured (42.155.033, 42.155.061, 42.155.021). The usefulness of the Stock radial velocity survey was evaluated (38.111.021, 39.111.037), as were the halo red giants (42.155.035, 39.155.154), and A and B stars (37.155.092). Carney also presented a useful review of stellar systems with distances greater than 25 kpc from the galactic center (38.155.076). The kinematics and metal abundances of globular clusters were the subjects of two new studies (38.154.013, 38.154.029). Fall and Rees also presented a new theory for the origin of the globular clusters.

8.2 Interstellar Matter

8.2.1 The Galactic Center

Kinematic studies of the nucleus of the Milky Way have brought about the discovery of a dense, clumpy CO disk 10 pc from the galactic center (40.155.009, 42.155.034). Other kinematic studies in the 63 μm fine structure line of oxygen (37.155.025), and 158 μm line of [CII] (42.155.015) have probed the mass distribution suggesting a thin azimuthally symmetric disk is Keplerian rotation around a central mass point of 7×10^6 $\mathcal{M}_\odot$. These studies are confirmed by observations of S(1) hydrogen line emission from the same region (42.155.029), and complemented by hydrogen recombination line synthesis observations (39.155.052). Vietri (42.151.004) examined the dynamical consequences of the gas ring and concluded that stability requires a triaxial galactic bulge rotating in a direction opposite to the disk material. The kinematic consequences of the ring have also been studied (40.155.020). An unusual, wide feature in the CO spectra of the galactic center is shown to consist of a number of gravitationally bound clouds (42.131.073). Two reviews of the radio and infrared observations of the galactic center were published by Oort (39.155.051) and by Hyland (41.155.013).

8.2.2 Galactic Rotation

A sizable number of papers on galactic rotation were published during the past triennium. New observations of HII region/molecular cloud complexes in the outer Galaxy (39.155.008, 38.155.022, 39.155.123, 39.155.195), as well as newly catalogued objects beyond the solar circle (42.155.026) have provided important data to determine the rotation curve in the disk to large R. An interesting new twist in deriving the rotation curve beyond the solar circle from 21 cm HI observations has also been published (42.155.002, 40.155.080). An unusual B supergiant was also used to determine the distant rotation law of the Galaxy (37.113.045).

Existing observations were used to reanalyze the inner and outer Galaxy rotation curves (40.155.016, 40.155.085, 41.155.036). An analysis by Haud (38.155.024) argues that the rise in the outer Galaxy rotation curve may be due to radial gas motions. A dynamical analysis of the inner Galaxy rotation curve argues forcefully that the data require a triaxial bulge potential (42.155.046). Caldwell and Coulson have completed a major new survey of distances and velocity measurements of Cepheid variables from which they derive the distance to the galactic center and Oort's A constant (Preprint 4). Nelson finds that the influence of magnetic fields on the rotation curves in the outer disks of galaxies can be quite significant (preprint 5).

8.2.3 Disk and Solar Vicinity

The velocity dispersion of HI clouds was subject to a number of new studies. The differences between HI and HII terminal velocities was confirmed (38.131.072), but the fraction of the high velocity dispersion HI gas was shown to be an order of magnitude smaller than originally proposed (39.155.084). The motions of some anomalous velocity HI clouds are argued to be from the envelopes of giant molecular clouds (39.131.091). An analysis of the motions of local clouds seen in absorption is found to be in good agreement with the standard solar motion (38.131.016), and the spectrum of turbulence appears to closely resemble a Kolmogoroff law (39.131.032).

The kinematics of molecular clouds has been the subject of some disagreement. Some investigators find a dispersion of $\sim$ 7 km.s^{-1} (37.131.320), while others find a value closer to 4 km.s^{-1} (38.155.055, 40.155.016). The velocity dispersion of the small, high-latitude molecular clouds shows an intermediate value of 5.4 km.s^{-1}, however (38.131.021, 38.131.267, 40.155.015). The random motions of molecular clouds have been argued to originate from the differential rotation of the Milky Way (38.131.229, 37.155.057). HI motions resulting from effects of the spiral arms was also studied by two different groups (37.155.083, 39.155.148, 42.155.007, Preprint 6).

The kinematics of various components of the solar vicinity were studied by Goulet and Shuter (38.155.079) who found strong deviations from circular rotation. Palous (42.155.060) has investigated how giant molecular clouds effect the stellar kinematics in the solar neighbourhood.

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8.2.4 High Velocity Clouds and the Halo

A number of new observations of high velocity clouds has been made (39.131.042, 39.131.043, 37.155.063 39.131.044, 39.131.045), the last of which is interpreted as high velocity inflow of HI toward the Galaxy. Other more local interpretations were also presented (38.131.079, 38.155.015), the first of which shows components of the high velocity clouds in the spectra of nine stars. This important observation, if confirmed, would imply that a large fraction of the high velocity clouds are within 200 pc of the Sun. Another study (42.155.054) suggests distances of 1–3 kpc. Clearly, the problem of the high velocity clouds requires more observations. A theoretical investigation by Lacey and Fall suggests that the star formation history of the Milky Way requires either radial infall or inflow from the outer regions of the galactic disk.

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9. The Outer Galactic Environment

One of the highlights of the study of the galactic environment is the demonstration that companions and hydrogen clouds surrounding our Galaxy form a ring-like structure similar to that surrounding external polar-ring galaxies. Probably this feature is common in giant galaxies. Dwarf galaxies may possess their own dark coronas, which fact, if confirmed, puts severe constraints on the nature of dark matter. Available evidence confirms earlier suggestions that our Galaxy with its massive corona, companions, and surrounding gas forms a single system with many mutual interactions. Most companions of our Galaxy as well as the main hydrogen streams are located in a narrow strip inclined 70° to the galactic plane.

(042.155.108) suggested that nearby companions and hydrogen streams probably form a polar ring around the Galaxy. There are evidently two types of high-velocity clouds (HVC's) of neutral hydrogen: relatively nearby features, and clouds at large distances from the Sun.

The polar ring of the Milky Way is composed of high-velocity gas of the second type. It is rotating with a velocity of $\sim$ 200 km.s^{-1}, approximately equal to the rotation speed of the Galaxy in its main plane. A similar match is observed in external galaxies with polar rings (043.151.002). These results demonstrate that coronas are triaxial with axial ratios of their equipotentials $c/a \sim 0.96$. The mass of the dark corona was derived using a number of various test particles. RR Lyrae stars and globular clusters yield the mass within 20 – 25 kpc; the results lie in an interval $2.6 - 2.9 \times 10^{11} \mathcal{M}_\odot$ (039.155.078; 040.122.159; 039.155.104); 039.155.113; 041.154.019; 040.154.015). The outer radius of the ring system is estimated to be $\sim$ 90 kpc. HVC's of the first type can be considered a consequence of interaction between the polar ring and galactic gas. Near the anticenter region accretion of the intergalactic gas to the Galaxy takes place. HVC streams, beginning there and smoothly merging to the polar ring structure may be the infalling hydrogen clouds. The infall of ring clouds into the galactic disk may give rise to the bending of the plane of the Milky Way, and may also trigger the formation of spiral structure, and thus explain a number of features in the kinematics of the population of young stars.

(039.151.016), (038.151.020), (038.151.070) and (038.157.165) discussed the stability of the galactic disk and the developing of its warp under the influence of the heavy halo. The infalling gas can also explain the constant scale height of the disk of Galaxy and the formation of HI loop structures. (039.155.054), (039.155.117), (040.131.283) and (042.155.087) reviewed the observations and theories involving the gaseous corona of the Milky Way.

(039.131.044), (039.131.045), (039.131.296), (040.156.008), (042.131.053), (039.131.043) and (039.131.042) describe recent observations of HVC's. (042.131.189) used *IRAS* observations to look for infrared emission from