THE KINEMATICS OF NEARBY STARS AND LARGE-SCALE RADIAL MOTION IN THE GALAXY

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ABSTRACT: The concept of star streams originally due to Kapteyn is revived. It is suggested that the existence of Stream II may have been overlooked, yet it is of crucial importance in specifying the true local standard of rest.

Kapteyn's star streams (SI, SII) in the solar neighbourhood have been generally overlooked for > 50 yr: see my remarks following E.R. Paul (these proceedings), and Eddington (1914), Eggen (1963), Upgren (1976), and Clube (1978). The present indications are that SI is a young population representative of the nearby spiral arm, with some contamination from the slightly older stellar groups pervading the solar neighbourhood; its mean velocity w.r.t. the Sun is $(u_I, v_I, w_I) \simeq (-23, -19, -8)$ km s^{-1}. SII on the other hand is a mostly late spectral-type population made up of stars with well-mixed orbits corresponding to the older galactic disc: $(u_{II}, v_{II}, w_{II}) \simeq (+16, -16, -7)$ km s^{-1}. Although the evidence for a Stromberg drift is well known, the dominant sense of the streaming here, SI relative to S II, is in a roughly orthogonal direction; indeed, if we take the not unreasonable view that SII defines the preferred l.s.r. (zero radial motion), then SI has a local non-circular motion directed outwards, $(u_{II} - u_I)$, of 39 km s^{-1}. There is some uncertainty in this figure of course, depending on the precision with which the stream motions have been determined (e.g. see Eddington, 1914), but probably no worse than ±5 km s^{-1}. On this hypothesis, it is only because SI is more dominant among all spectral types (50-100%) within the immediate solar neighbourhood (< 300 pc) that the currently adopted l.s.r. with $(u_s, v_s, w_s) \simeq (-10, -16, -7)$ km s^{-1} inclines towards SI rather than SII.

Since the nearby young stars (≃SI) produce a deviated velocity ellipsoid, it is expected that merged stellar populations beyond 300 pc will produce a u-value that tends towards that of SII and a less deviated "ellipsoid". Both these effects are borne out in a recent study (Clube et al. 1983) of the kinematics of ~ 1000 O,B-type stars within 2000 pc. Similarly, beyond 300 pc, we might expect to see otherwise unexplained changes in mean $\bar{u}$ along the anticentre and centre directions, reflecting the greater presence or otherwise of SI. Two recent studies

H. van Woerden et al. (eds.), The Milky Way Galaxy, 145–147.

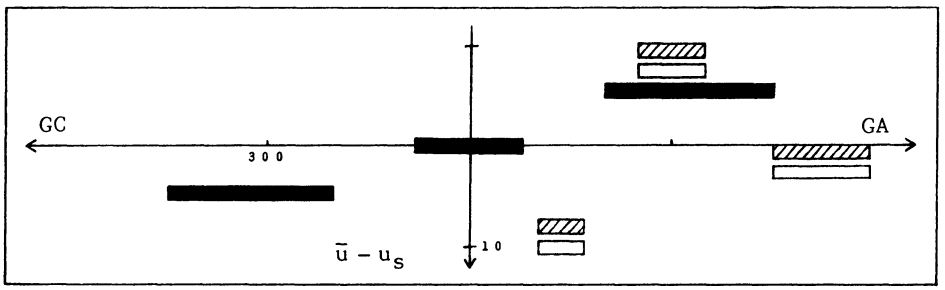

Figure 1. Trend in $\bar{u}$ through solar neighbourhood.

of ninth-magnitude K stars (Woolley et al. 1977, Griffin et al. 1983), mostly giants, seem to bear out these predictions. Thus, in the figure are plotted values of $\bar{u}$ inferred from Woolley et al. (1977) at various distances for groups of stars along anticentre lines of sight towards $b = \pm 20^\circ$. The strong correlation above and below the plane suggests a real effect and there is also a striking displacement of $\bar{u}$ towards SI at $\sim$ 350 pc where the nearest O,B associations in the Orion spur congregate (Blaauw 1985). No further associations are encountered within 1500 pc in these directions. Also in the figure are plotted values of $\bar{u}$ for two groups of K-stars of similar apparent magnitude spanning the regions ($l = 0^\circ \pm 60^\circ$, $20^\circ < |b| < 40^\circ$) and ($l = 180^\circ \pm 60^\circ$, $20^\circ < |b| < 40^\circ$). Again there is a significant difference with the u-value of the galactic-centre sample tending towards that of SII. In both cases also, $|v| > |v_s|$, the anticentre sample reflecting differential galactic rotation and the centre sample apparently reflecting the Stromberg drift of an older population.

If these observations are correctly interpreted and SII truly corresponds to the preferred l.s.r., a redetermination of the mean motion of the halo is important. It has been suggested previously for example that the globular-cluster system is locally infalling (Kinman 1959), but this effect may well have been underestimated due to the influence of expanding motions near the centre of the Galaxy (Clube and Watson 1979). Of similar importance are direct observations of the Galactic nucleus (see Clube et al. 1983): thus the significance of Kapteyn's SII appears enhanced by the fact that the cores of the H_2CO, Ne II and 511 MeV electron-positron annihilation lines are centred on Sgr A West, and by the fact they are all receding from the conventional l.s.r. at 40-50 km s^{-1}. The molecular ring of the Galaxy also now appears to be bounded on its inner face (Bania 1985) by the 3 kpc expanding arm (-55 km s^{-1}) and the +135 arm, and symmetry here would similarly suggest the centre is receding at 40 km s^{-1}.

The existence of Kapteyn's Stream II is evidently a question of fundamental importance to our understanding of solar-motion variations, and should it now be re-established, there may be far-reaching implications for our understanding of the kinematics of the Galaxy as a whole.

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A. Blaauw (centre, background) introduces R.J. Allen, Chairman of Department of Astronomy, and J. Borgman, President of Groningen University, to descendants of J.C. Kapteyn CFD

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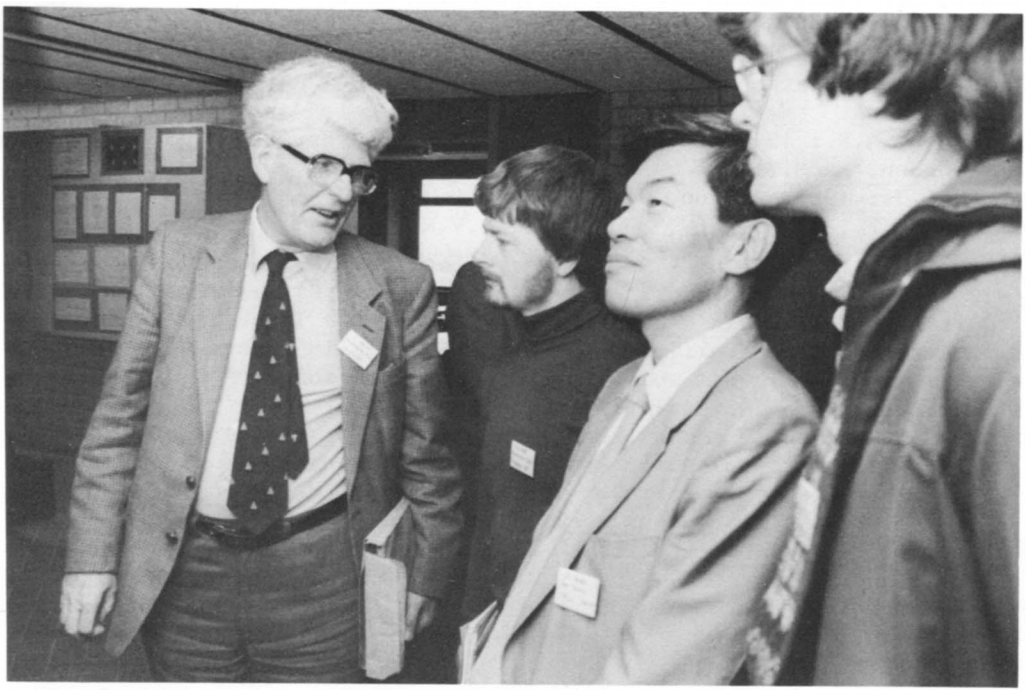

(Left to right) Murray, Reid, Okuda and Brink discussing posters CFD

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