Case Institute of Technology, Cleveland), has obtained a space density of M dwarfs comparable to that of MS. This result is based on a red-spectral - region survey of 1720 square degrees of the Southern sky with the 6° prism of the Curtis - Schmidt telescope at Cerro Tololo. Despite Smethel's result, however, one tends to believe that the space density of M dwarfs in the solar vicinity is of the order of 0.06 stars / pc^3, such as was calculated by Luyten in 1968.

The question now is whether we should abandon the idea of high space density of M dwarfs at all. I think we may do so for brighter M dwarf stars, but then we have no solution of the problem of the missing mass. Despite that Einasto and his group have some doubts on the existence of a missing mass in the solar neighbourhood, we should study Kumar's suggestion of the possibility that there are many stars in the mass range 0.01-0.07 $M_\odot$ in our galactic space still to be discovered, and which can provide extra mass for the solution of Oort's missing mass problem. A new support for the existence of such stars has been given by Van de Kamp's (*Ann. Rev. of A. and Ap.*, **13**, 295, 1975) results of his study of unseen companions of stars in our immediate surroundings. BD+68° 946, Barnard's star, and BD+43°4305 have unseen companions with masses lying in the above mentioned range. At a colloquium held at the Amsterdam Astronomical Institute, van de Kamp showed that, if one makes a statistical study of the unseen companions of seen stars up to 25 pc from the Sun, there is a possibility that Oort's missing mass is hidden as unseen companions.

Van de Kamp's results do not mean, however, that the missing mass problem is completely solved. We know that the semi-theoretical determination of the density of matter (ρ_{dyn}) in the solar neighbourhood must still be improved. Several working groups are at present busy determining a new value of ρ_{dyn}. Radford, for instance, (private communication) has obtained a quite high preliminary value: 0.30 $M_\odot/\mathrm{pc}^3$. We are anxious to know at what value other working groups (Hill et al., *Memoirs* R.A.S., **82**, 69, 1976), Osburn (Venezuela), Florsch (Strasbourg) will arrive.

At the Amsterdam Astronomical Institute a blink-survey of red stars on copies of Mt. Palomar Schmidt blue and red South Galactic Pole plates, up to the plate limit ($V \simeq 20$ mag) is in progress. This should provide information on the space density of black dwarfs in the solar neighbourhood. We are wondering whether the many faint red stars we have found in our survey region (6 sq. degr.) are distant normal main sequence M dwarfs, or nearby degenerated below - the - main-sequence black dwarfs. For answering this question the parallax survey conducted by Murray at the SGP on plates obtained with the new Siding Spring Schmidt telescope is of paramount importance. In this survey Murray (New Problems in Astrometry, IAU Symp. No. 61) hopes to obtain an accuracy of 0."01, implying that it will be complete up to a distance of say 30 pc from the Sun.

Work is afoot, jointly with T. de Jong, on the evolution of low-mass stars which will ultimately become black dwarfs to find the expected number of black dwarfs in the solar neighbourhood.

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THE DISAPPEARANCE OF THE UNSEEN (EVAPORATING BLACK HOLES)

It has been suggested that in the very early stages of the evolution of the Universe, extremely high density fluctuations in spacetime (Misner, Thorne, Wheeler, *Gravitation*, San Francisco : Freeman, 1973) could create exceptionally low mass black holes (e.g. $M = 10^{15}$ g, $R = 10^{-13}$ cm) (Hawking, *Mon. Not.* R. *astr. Soc.*,**152**, 75, 1971). In fact, the minimum size, corresponding to the Planck length $(Ghc^{-3})^{1/2} \approx 10^{-33}$ cm, would correspond to 10^{-5}g. Recently, in attempting to apply quantum field theory to gravitationally collapsed objects, Hawking has found that black holes can emit energy so that, if small enough, they can cease to exist. One interesting question with respect to these small black holes is "How does the uncertainty principle apply, especially to the region at the edge of a black hole?" However, a proper answer to such an inquiry is the application of quantum field theory, with gravitational coupling, to the vacuum region in question.

Bardeen, Carter and Hawking (*Commun. Math. Phys.*, **31**, 161, 1973) found that black holes (regardless of type-Schwarzschild, Kerr-Newman, etc...) are analogous to thermodynamic systems. Thus, they should have a temperature and should radiate even when in equilibrium. Although the physical radius of any black hole is infinite, in the sense of the length of a rod passing through it, the circumference is quite finite, as is the surface area,

$$A = 4\pi\,[2M^2 - Q^2 + 2(M^4 - J^2 - M^2Q^2)^{1/2}],$$

wherein M=mass of black hole
J =angular momentum
Q=charge

if the Kerr-Newman metric is used (Hawking, *Phys. Rev. D.*, **13**, 2, 192).

The work of Bekenstein in 1972 (J.D. Bekenstein, *Phys. Rev. D.*, **7**, 8, 1973) shows that, surprisingly, the surface area of a black hole is equivalent to entropy, and the surface gravity ($K = \frac{4\pi Rc^2 - GM}{A}$, where R is the "apparent radius" of the black hole) corresponds to the temperature. Using an information theory approach, Bekenstein showed that the surface area of the event horizon is the logarithm of the number of different configurations that could collapse to a black hole whose only quantum numbers are mass M, charge Q and angular momentum J. This, then, implies that the black hole has a temperature proportional to K and should emit energy thermally. In fact, Bekenstein established the validity of a generalized second law of thermodynamics with the implication that thermal equilibrium cannot be maintained by a black hole immersed in matter. Moreover, since Einstein's field equations are separately invariant under charge, parity and time reversal, the time reversed process is also allowed, and a white hole will emit in the same fashion as a black one. Therefore, the two cannot be distinguished by an outside observer.

Quantum field theory is a means of calculating elementary processes by assuming that the vacuum (in this case the region at the edge of the collapsed object) is filled with "virtual pairs" of particles and antiparticles which can sometimes interact with matter passing though this region or with each other. A member of such a pair may find itself slightly outside a black hole and become scattered away by the gravitational field of that hole and escape. Detailed calculation of such escapes show that (1) for a given black hole the distribution of scattered particles is thermal, and (2) the likelihood of scatter is inversely proportional to the surface area of the black hole--that is, the "thickness" of the edge of the collapsed mass is proportional to R and as R decreases, tunnelling is more favoured. For instance, a black hole of one solar mass would radiate so slowly that it would last for 10^{66} years, whereas one of mass 10^{15} g would last $\sim 10^{10}$ years and radiate with an initial power of 6×10^{9} watts (Hawking, *Scientific American*, **45**, 18, 1977). At low temperatures, thermal radiation is exclusively photons, but at very high temperatures all kinds of elementary particles can be expected to be released and the final decay should be a very explosive (and detectable) event.

Thus it appears that both information theory and quantum field theory give the same result that black holes emit radiation and if initially small enough, can evaporate entirely.

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STATEMENT OF OWNERSHIP

Statement of particulars regarding BULLETIN OF THE ASTRONOMICAL SOCIETY OF INDIA, as required to be published under section 19-D, subsection (b) of the Press and Registration of Books Act read with Rule 8 for the Registration of Newspaper Central Rules, 1956 as amended).

1.	Place of Publication	Tata Institute of Fundamental Research, Homi Bhabha Road, Bombay 400 005
2.	Periodicity ot Publication.	Quarterly
3.	Publisher, Printer and Editor	M. S. Vardya
	Nationality	Indian
	Address	Tata Institute of Fundamental Research, Homi Bhabha Road, Bombay 400 005
4.	Name and address of the owner	Astronomical Society of India, Osmania University, Hyderabad 500 007

I, M. S. Vardya, hereby declare that the particulars given above are true to the best of may knowledge and belier.

March 1, 1977 (Sd.) M. S. Vardya
