

ERRATUM

In the paper "Energy Spectrum of Hydrogen-like Atoms in a Strong Magnetic Field" by G. L. Surmelian and R. F. O'Connell (*Ap. J.*, 190, 741 [1974]), due to a typographical error, the parameter A_5 appearing in Table 1 has a minus sign in front of its numerical value. This minus sign should be replaced by a plus sign. The rest of the paper remains unchanged. The authors would like to thank Dr. A. Dickinson for bringing this point to their attention.

ABSTRACTS OF ASTROPHYSICAL JOURNAL SUPPLEMENT SERIES FOR THE 1976 MARCH ISSUE

THE MASSES OF GLOBULAR CLUSTERS. I. SURFACE BRIGHTNESS DISTRIBUTIONS AND STAR COUNTS

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Surface brightness distributions have been determined for 10 concentrated globular clusters from photoelectric surface photometry using centered apertures and small-aperture drift scans across the clusters. Star counts have been used to extend the distributions in the outer regions. The 10 clusters studied are NGC 104 (47 Tuc), NGC 362, NGC 1851, NGC 2808, NGC 6093 (M80), NGC 6266 (M62), NGC 6388, NGC 6441, NGC 6715 (M54), and NGC 6864 (M75). The observed distributions are compared with the theoretical surface density distributions from King's models of globular clusters. Central surface brightnesses, core radii, tidal radii, and total magnitudes derived from this comparison are tabulated, as are the parameters which will be used in Paper II, in conjunction with the central velocity dispersion, to give masses and M/L values for these clusters. Reddenings and distance moduli determined from consideration of all available data are also given.

ABSOLUTE CALIBRATION OF MILLIMETER-WAVELENGTH SPECTRAL LINES

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A detailed analysis of the chopper-wheel method of calibrating the intensity of a millimeter-wavelength spectral line is presented. Special techniques were used to construct a receiver which eliminates most of the usual calibration difficulties. The zenith atmospheric extinction between 3.5 mm and 2.6 mm wavelength was measured, and the intensities of six spectral lines in this range were absolutely calibrated with an estimated uncertainty (1σ) of 7 percent. The effects of the antenna power pattern on the corrected antenna temperature T_A^* are calculated for several simple models of the source brightness distribution.

WATER EMISSION FROM INFRARED STARS

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Twenty-two new infrared stars with microwave water-vapor emission have been found, all but four of which are optically identified long-period variables. They are heavily reddened, late M stars that commonly show time variations. Hydroxyl emission is present in all but a few instances. Excited-state SiO emission is seen in many H_2O -infrared stars (although about half have not yet been checked). Those that are Mira variables always have a visual change of more than 6 mag during their light cycle. Other optical and infrared properties are discussed.

THE NATURE OF THE OBJECTS OF JOY: A STUDY OF THE T TAURI PHENOMENON

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Analysis of spectroscopic and photometric data for 49 T Tauri stars suggests a plausible model for the unusual optical and infrared emission features characteristic of the class. Emission processes in a hot gaseous envelope surrounding a cool stellar photosphere account well for the observed emission lines, blue and ultraviolet "veiling," and a large fraction of the infrared excess at $\lambda < 10\mu$; temporal changes in the envelope emission are the likely source of the observed variability. The large majority of T Tauri stars appear to be young (age $\leq 10^6$ years), low-mass ($M < 3 M_\odot$) stars approaching the main sequence along quasi-static equilibrium tracks.

SPECTRA OF SOME OHIO RADIO SOURCES: LIST V

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We are continuing to sift the Ohio catalog for radio sources that have centimeter-excess (CE) spectra. The present list (V) brings the total number of sources in Lists I to V to 273.

Flux densities at 1415 and 2650 MHz were measured with the 104 m \times 21 m telescope of the Ohio State University Radio Observatory (OSU), while flux densities at 3.2, 6.6, 10.6, and 22.2 GHz were measured with the 46 m telescope of the Algonquin Radio Observatory (ARO). The rms accuracy of the flux densities at 1415 MHz is $[(0.2)^2 + (0.10S)^2]^{1/2}$ Jy, where S is the flux density. 0.3 Jy is a reasonable estimate of the accuracy at 2650 MHz. At 3.2, 6.6, and 10.6 GHz the function $[(0.05)^2 + (0.06S)^2]^{1/2}$ Jy is a good approximation to the rms accuracy of the flux densities. The random errors at 22 GHz have an rms value $[(0.06)^2 + (0.15S)^2]^{1/2}$ Jy. The ARO positions

are compared with positions measured at Bologna, Malvern, Molonglo, Parkes, and Texas. Agreement is generally in accordance with the quoted accuracies of 20" or better.

We direct the reader's attention to a few interesting features of the data:

1. OG 147 is a strong and variable source that may be associated with a blue stellar object.

2. OM 280, ON 428, OR 306, OV 239.7, and OW 340 seem to have straight spectra with spectral index close to zero over a 50:1 range of frequencies.

3. OW 316 has a spectrum of singular shape. It is peaked at ~ 3 GHz. On the low-frequency side the spectral index is -1.3 , on the high-frequency side ~ 1.8 . The combination of these two features suggests the inverse Compton effect. OW 316 may therefore be a source of X-rays.

MULTIPLICITY AMONG SOLAR-TYPE STARS

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A search has been made for spectroscopic binaries among 135 F3-G2 IV or V bright field stars. As a result of measuring 20 coudé radial velocities per star, we derived orbital elements for 25 newly discovered spectroscopic binaries. These data are combined with known orbital elements for 21 spectroscopic binaries, orbital elements for 23 visual binaries, and data for 25 common-proper-motion pairs. The observed frequencies of singles:doubles:triples:quadruples are 42:46:9:2 percent. The period distribution for the 88 periods has a single maximum, a large overlap between spectroscopic and visual pairs, and a median period of 14 years. Use of four-color and H β data shows no correlation between duplicity and age, or any strong decrease in duplicity rate toward lower masses.

It was found possible to estimate rather well the number of binaries not revealed by this study. The incompleteness study was based on seven reasonable assumptions and leads to the result that there are really 1.4 companions for each primary star, on the average. This result implies that single stars are rare.

It is also possible to determine statistically the secondary masses for both the observed and undetected binaries. These masses show that for binary periods less than about 100 years, the frequency of secondary masses varies as $M_2^{1/3}$, which is a marked departure from the van Rhijn distribution for single stars. However, for periods greater than 100 years, the frequency of various secondary masses fits the van Rhijn function within our accuracy, which is lower in this case than for the shorter periods. We conclude that there are

two types of binaries: those with the shorter periods are fission systems in which a single protostar subdivided because of excessive angular momentum, whereas the longer periods represent pairs of protostars that contracted separately but are gravitationally held to each other. The dividing period of 100 years is such that if two solar masses were distributed over the corresponding volume, the mean density agrees with that assumed for the solar nebula at the time of planetary differentiation.

We find that two-thirds of the primary stars have stellar companions. If we assume that the cube-root mass function for periods less than 100 years holds for degenerate stars and planets ($< 0.07 M_\odot$) too, we find that one-third of the primaries have such companions, i.e., all the primaries are fission systems. This tentative conclusion seems reasonable in that it solves the problem of excess angular momentum in the contraction of a protostar from an interstellar cloud. In addition, about 72 percent of the primaries have distant ($P > 100$ years) companions. Perhaps the distant companions are themselves fission doubles for the same reasons that the primaries are double. We conclude that perhaps all primaries in the range F3-G2 IV, V are either doubles (with nearby stellar or degenerate companions) or quadruples (in at least 72 percent of the cases) with a distant pair that resulted from a separate protostar.

The total mass in the companions is just half of the total mass in the primaries. On the average, the multiple systems are 0.22 mag brighter than the primaries alone.

STELLAR POPULATION SAMPLES AT THE GALACTIC POLES. III. (*UBVRI*) OBSERVATIONS OF PROPER MOTION STARS NEAR THE SOUTH POLE AND THE LUMINOSITY LAWS FOR THE HALO AND OLD DISK POPULATIONS

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Some 1200 *UBV* and 650 *R, I* observations of 1050 stars, mostly with annual proper motion greater than $0''.096$, brighter than visual magnitude 15, and within 10° of the south galactic pole, are presented and discussed. The M-type stars ($B - V > +1.15$ mag) in the sample are discussed in a current article in *The Astrophysical Journal*, Part I. The bluer stars indicate that (1) the slopes of the luminosity laws for old disk and halo stars are fairly similar to M_V near +6 mag, (2) the old-disk population law has an inflection point near $M_V = +7$ mag, (3) the halo population law may peak near $M_V = +9$ mag on a broad plateau that continues to beyond +10 mag and drops to zero near +13 mag, and (4) the upper limit for the mass density of the halo population near the Sun is near $9 \times 10^{-4} M_\odot \text{pc}^{-3}$. Many stars of particular interest in the sample are briefly discussed. These include several possible red subluminal stars, one of which may be a very close solar neighbor; some halo population giants; and one unique flare star with an amplitude near 0.5 mag in *R*.