star show that the former will not survive for more than a few million years. Also, it is doubtful if a solar system can be formed around a G, K, or M dwarf if it is accompanied by a low-mass companion. The so-called single main sequence stars of spectral type later than F5 may have lost angular momentum by the Schatzman mechanism or by some other mechanism, but they may not possess solar systems if they are accompanied by close low-mass companions. Since the occurrence of double (or triple) stars is a universal phenomenon, it is suggested that the number of solar systems in the Galaxy may not be as large as given by Struve, Huang, and other workers.

Theoretical Molecular Line Absorption of CO in Late Spectral Type Atmospheres. VIRGIL G. KUNDE, *Goddard Space Flight Center*.—The line positions, line intensities and collisional line half-widths have been calculated for the fundamental, first overtone, and second overtone vibration-rotation bands of $^{12}\text{C}^{16}\text{O}$ and $^{13}\text{C}^{16}\text{O}$. The $^{12}\text{C}^{16}\text{O}$ and $^{13}\text{C}^{16}\text{O}$ line intensities were computed for temperature ranging from 175–3500°K and were weighted in accordance with a terrestrial $^{12}\text{C}/^{13}\text{C}$ abundance ratio. All lines within 5–6 orders of magnitude of the maximum line intensity of a band have been considered (~ 4500 lines at 3500°K). Tables of the above molecular absorption line parameters are being published (Kunde, NASA Document X-622-67-248, June 1967).

The CO mass absorption coefficient has been computed for several typical late spectral type stellar atmosphere conditions. The straight mean absorption coefficient has been evaluated for these conditions in several ways: (1) line-by-line integration technique, (2) quasi-random band model, and (3) $S_T^m/\Delta\nu$ approximation, where S_T^m is the total line intensity in spectral interval $\Delta\nu$. The results indicate the simpler $S_T^m/\Delta\nu$ model represents the CO mean absorption coefficient in the late-type atmospheres generally to an accuracy better than 1% if the spectral intervals are greater than 5 cm^{-1} . For regions short of 1600 cm^{-1} , the accuracy of the $S_T^m/\Delta\nu$ model is 5–10%. The quoted accuracies are based on the fundamental band for $T=2500^\circ\text{K}$, pressures up to 2 atm and turbulent velocities up to 10 km/sec. The mean absorption coefficient $S_T^m/\Delta\nu$ has been determined for CO for temperatures of 1000°, 2500°, and 3500°K.

On the Spectra of Stellar Flares. WILLIAM KUNKEL, *University of Texas*.—During an investigation of flares on dMe stars conducted at McDonald Observatory in 1965 and 1966 about 30 flares were recorded on each of the most intensively observed stars, AD Leo, YZ CMi, and Wolf 359,

monitored in sequentially sampled U , B , V . To identify the emission processes responsible for flare light time-resolved low-resolution (250 Å/mm) spectra were obtained of flares on EV Lac, AD Leo, and YZ CMi.

In contrast to the prevailing view that invokes nonthermal emission to explain flare light, a two-layer model of flare emission involving only thermal processes is proposed that matches the observations.

The upper or chromospheric layer radiates by free-free, bound-free, and discrete transitions in hydrogen. Temperatures between 19 000°K and 24 000°K are indicated by the Balmer jump and the gradient. The Balmer decrement points to strongly self-absorbed lines with τ_0 at the center of $H\alpha$ between 200 and 1000 on the average, if the line broadening parameters are made similar to those that apply in solar flares. The colors of this layer are in the neighborhood of $U-B=-1.30$ and $B-V=-0.28$.

The lower layer is the photosphere itself, which responds to the impulsive heating from above with an increase of flux ("back-light") whose colors are assumed to be the same, to a first approximation, as those of the undisturbed photosphere. Since the temporal response of the photosphere lags behind the excitation from the upper layer, the contribution by backlight will increase with time, as is evidenced by a flare development track in the $U-B$, $B-V$ diagram with slope $d(U-B)/d(B-V)=0.3$ directed toward the red quadrant. This is very nearly the value observed in flares where backlight appears in greatest strength.

The results invite the conclusion that the available observations of dMe flares are consistent with emission processes indistinguishable from those found in solar flares, and that in particular it is not necessary to invoke nonthermal emission to explain flare light.

A Correction to the Equation of the Conservation of Energy as Commonly Used in the Theory of Stellar Evolution. G. S. KUTTER AND M. P. SAVEDOFF, *The University of Rochester*.—The correct form of the equation of the conservation of energy for the general case that includes composition changes, as by nuclear transmutation or by convective mixing, is

$$\frac{du}{dt} = -\frac{dL}{dm} - \epsilon_v + \epsilon_n - P \frac{d}{dt} \left(\frac{1}{\rho} \right) - T \sum_A \frac{\partial s}{\partial \mu_A} \bigg|_{u, \rho, \mu_{A'} \neq A, \mu_e} \frac{d\mu_A}{dt} \\ - T \frac{\partial s}{\partial \mu_e} \bigg|_{\mu, \rho, \mu_A} \frac{d\mu_e}{dt}.$$

s is the total entropy per gram. The last two terms have been neglected in the theory of stellar evolu-