the expansion is 3.64×10^9 yrs. This is in agreement with the probable range of astronomical time given by Bok and it is not in disagreement with the estimation made by Holmes of the age of the earth as an independent body. The calculated red-shifts agree with the observed red-shifts given by Hubble to within 0.1 mag. except for the two Ursa Major clusters. The calculated values of $\log N$, the nebular counts, depart from the observed values presented by Hubble by 0.002 or less.

The tentative nature of the model must be emphasized. The postulates of zero-pressure and co-moving coordinates are faulty near the time of the beginning of expansion. The physical conditions to be expected with the beginning of expansion are high density, high radiation pressure, and a dispersion in initial velocities. The astronomical data that are used are subject to revision. The chief value of the model possibly lies in showing that currently accepted astronomical data can be treated by accepted physical principles without the necessity of introducing new physical hypotheses.

*California Institute of Technology,
Pasadena, Calif.*

Page, Thornton. The spectra of double galaxies.

A new grating spectrograph with a parabolic-mirror collimator and a solid Schmidt camera of $f/0.65$ focal ratio, has been used at the prime focus of the 82-inch telescope of the McDonald Observatory to observe the double spectra of twelve close pairs of spiral nebulae selected from Holmberg's *Catalog of Double and Multiple Galaxies*.¹ The spectra are in good definition from $\lambda 3700$ to $\lambda 6700$ and have a dispersion of about 350 Å/mm.

The primary purpose of the investigation is to determine the average mass of a spiral in a double system from the measured differential radial velocities, this to be compared with individual masses determined from rotations, and with the average mass in clusters of nebulae, determined from the dispersions in radial velocities. Although accurate measurements are not yet complete, it appears that the average mass of spirals in double systems is 10^{10} suns or less. An average mass of 10^{13} suns is required to explain in relativistic cosmology the curvature of space necessary to account for Hubble's surveys of the nebulae.

The spectra show emission lines in 17 out of 24 cases, the lines observed being those of H ,

$[O\text{ III}]$, $[O\text{ II}]$, $[N\text{ II}]$, and $[S\text{ II}]$. The forbidden-line emission is strongly correlated with $H\alpha$ emission; 11 of the 24 spectra show both $H\alpha$ and $[O\text{ II}] \lambda 3727$, 4 show $H\alpha$ without $\lambda 3727$, 2 show $\lambda 3727$ without $H\alpha$, and 7 (of which 4 are underexposed) show no emission lines. There is no apparent correlation between the line emission and either the separation of the components of a double, or the distance (using apparent magnitude as a distance criterion). The smaller nebulae seem less likely to show $H\alpha$ emission, and, probably because of the occulting matter near the equatorial plane in a spiral, edge-on spirals seem less likely to show $H\alpha$ emission than those square-on.

In many cases the $[O\text{ II}] \lambda 3727$ emission extends farther from the nucleus than the $H\alpha$ emission, and in at least one case (NGC 3395-96) it extends completely across between the two galaxies..

1. *Ann. Obs. Lund* No. 6, 1937.

*Yerkes Observatory,
Williams Bay, Wis.*

Petrie, R. M. New radial velocities for some brighter members of the Ursa Major Cluster.

Radial velocities have been determined for nineteen stars of the Ursa Major cluster from 156 spectrograms using high dispersion (11 Å/mm at $H\gamma$) and new revised wave-lengths. Controls and comparisons demonstrate that systematic errors are negligible and that the velocities agree exactly with the Lick system.

Analysis of the results verifies a cluster motion of 16.7 km/sec from radial velocities in disagreement with the value derived from proper motions and trigonometrical parallaxes, 18.1 km/sec. It is definitely established that the eleven nucleus stars yield a cluster motion from radial velocities some 8 km/sec less than that given by the non-nucleus stars. It is found that the gravitational shift is unable to account for the positive residuals exhibited by the nucleus stars and it is suggested that these stars form a compact moving cluster with a motion different from that of the extended stream.

*Dominion Astrophysical Observatory,
Victoria, B.C.*

Pettit, Helen B. Photometric observations of the night sky at elevation of 2300 feet.

Ground observations of the intensity of the light of the night sky have been made at the