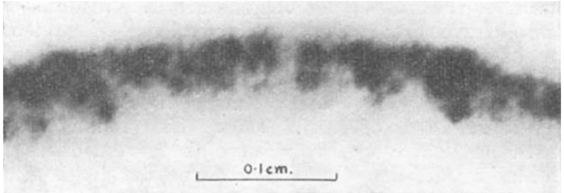

Autoradiograph of steel surface showing location of copper fragments transferred during sliding

water did not affect the activity on the copper; but it removed all but $2\frac{1}{2}$ iodine layers from the steel surface. It is possible that this residual iodine layer was of monolayer thickness only, the factor of $2\frac{1}{2}$ being the ratio of real to apparent surface area for the lapped steel specimen[5].

The accompanying illustration shows an autoradiograph of the friction track produced by a clean, hemispherically ended copper specimen sliding on steel under a load of 1 kgm., after which the iodine solution was applied for fifteen seconds, the surface washed with cold water and a two-day exposure given on 'No-Screen X-Ray' film. The copper wear fragments transferred to the steel are shown as black circular patches along the (curved) sliding track, while the background due to the steel is nearly invisible. The general appearance of the friction track is very similar to one shown by Rabinowicz and Tabor[6], who obtained their autoradiograph by an entirely different method using a radioactive copper specimen.

Of a number of metals and alloys examined, silver, chromium, lead and copper react most strongly with the iodine ($\sim$ 200 atomic layers); indium, tungsten carbide and brass react less vigorously ($\sim$ 50 layers); aluminium, bismuth, nickel, antimony, tin, cadmium and mild steel produce still thinner films ($\sim$ 15 layers); while zinc and titanium take up only three atomic layers.

The radiochemical method would appear to have considerable potentialities in surface autoradiography. Since only the surface itself is activated, good resolution can be achieved, while flexibility is ensured by the large number of radioactive chemicals and solvents that can be used to achieve a difference in the radioactive intensity at various regions on the surface.

E. RABINOWICZ

Lubrication Laboratory,
Department of Mechanical Engineering,
Massachusetts Institute of Technology,
Cambridge, Mass. May 23.

[1] Hillert, M., *Nature*, **168**, 39 (1951).
[2] Rabinowicz, E., *Proc. Phys. Soc.*, A, **64**, 939 (1951).
[3] Michael, Leavitt, Bever and Spedden, *J. App. Phys.*, **22**, 1403 (1951).
[4] Westermark and Erwell, *Nature*, **169**, 703 (1952).
[5] Bowden and Rideal, *Proc. Roy. Soc.*, A, **120**, 80 (1928).
[6] Rabinowicz and Tabor, *Proc. Roy. Soc.*, A, **208** 455 (1951).

Gravitational Instability of a Turbulent Medium

CHANDRASEKHAR has derived in a very elegant manner[1], from his theory of density fluctuations in an isotropic homogeneous turbulence field[2], the generalization to a turbulent medium of Jeans's criterion for the stability against inhomogeneity of an infinite quiescent homogeneous medium. The expression which he obtains may be written:

$$\lambda^2 = \frac{\pi}{G\rho}\left(c^2 + \tfrac{1}{3}\overline{u^2}\right) = \frac{\pi}{G\rho}\left(\gamma\frac{k\theta}{m} + \tfrac{1}{3}\overline{u^2}\right), \qquad (1)$$

where λ is the critical length for stability, c is the speed of sound in the medium, θ the temperature, m the mass of a gas molecule, and $\overline{u^2}$ the mean square velocity of the turbulence field.

First, we should like to point out that because of the slow change in density in this process, the temperature will not vary adiabatically, as in the case of the relatively high frequencies involved in most acoustic radiation, but rather will approximately obey a polytrope law of the form

$$\theta = \theta_0\left(\frac{\rho}{\rho_0}\right)^{\alpha-1}, \qquad (2)$$

where α is adjusted to give the best fit to the theoretical equilibrium temperatures[3]. One finds approximately $0\cdot4 < \alpha < 1\cdot00$ in $H_{\rm I}$ regions and $1\cdot00 < \alpha < 1\cdot04$ in $H_{\rm II}$ regions. Thus γ should be replaced by α in equation (1).

Secondly, we should like to point out that expression (1) may be derived by some simple physical arguments. From the virial theorem one sees that it is the internal translational velocities of the molecules which oppose the gravitational forces. The kinetic temperature is defined as a direct measure of these motions. Thus, we define a 'turbulence temperature' Θ by

$$3k\Theta = m\overline{u^2}. \qquad (3)$$

We also assume that

$$\Theta = \Theta_0\left(\frac{\rho}{\rho_0}\right)^{A-1}. \qquad (4)$$

Now, without turbulence,

$$\lambda^2 = \frac{\pi k}{G\rho m}\,\alpha\theta,$$

so that $\alpha\theta$ is the quantity characteristic of the internal stability of the medium. To include the turbulence, therefore, we simply replace $\alpha\theta$ by $\alpha\theta + A\Theta$. We obtain

$$\lambda^2 = \frac{\pi k}{G\rho m}\left(\alpha\theta + A\Theta\right). \qquad (5)$$

If we assume, after Chandrasekhar, that $\overline{u^2}$ is independent of time, while ρ is varying, then $A = 1$ and we have:

$$y^2 = \frac{\pi k}{G\rho m}\left(\alpha\theta + \Theta\right).$$

If

$$c^2 \equiv \alpha\,\frac{k\theta}{m},$$

and is the velocity of sound with period less than the thermal relaxation time of the gas, then we may write

$$\lambda^2 = \frac{\pi}{G\rho}\left(c^2 + \tfrac{1}{3}\overline{u^2}\right).$$

E. N. PARKER

Department of Mathematics and Astronomy,
University of Utah.
Salt Lake City.
Utah.
May 27.

[1] Chandrasekhar, S., *Proc. Roy. Soc.* A, **210**, 18 (1951).
[2] Chandrasekhar, S., *Proc. Roy. Soc.*, A, **210**, 26 (1951).
[3] Spitzer, jun., L., and Savedoff, M., *Astrophys. J.*, **111**, 593 (1950).