Zwicky catalogue is due to a uniform field, we would have, according to equation (2)

$$N(< m) = 1.84 \times 10^{-6}\, 10^{0.6m}$$

Such a hypothetical field must be at least a factor 6.5 less dense, that is,

$$N(<m) \leq 2.8 \times 10^{-7}\, 10^{0.6m}$$

This result agrees with Soneira and Peebles[12], and Fall *et al.*[11].

I have tried to stress the simple and straightforward way of setting an upper limit for the density of the hypothetical uniform field of galaxies. It is, therefore, important to look for redshifts in rather large regions and observe fainter magnitudes to see if the gaps in redshifts remain and whether we keep finding non-uniformity both in the surface distribution and in depth.

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Joule dissipation in F-region and equatorial spread-F events

THE dissipation of turbulent electric fields varying with time, which are associated with spread-F in equatorial regions, has been thought to cause significant heating of the neutral atmospheric gases at F-region altitudes and higher[1]. The time-varying electric fields have been shown to exist during spread-F at Jicamarca[2], and the two phenomena are known to occur with high probability in a latitudinal belt about 30° wide centred on the magnetic equator[3]. The theory of formation of large-scale field-aligned irregularities[1] from which small-scale irregularities, as in spread-F, may develop[5] suggests that if spread-F occurs, it will happen all along the magnetic tube of force[4]. This inference is consistent with the observations[3] of 'turbulent' electrostatic fields from satellite OVI-17. We describe here recent experimental measurements of neutral atmosphere temperatures at F-region heights at Mt Abu (24.6°N, 72.7°E geographic; 15.0° geomagnetic latitude) which agree with the theoretical prediction of very great atmospheric heating in equatorial spread-F events[1].

A digitally pressure-scanned Fabry-Perot spectrometer from the Physical Research Laboratory, Ahmedabad, was tested by measuring the Doppler width of 6,300 Å O(^{1}D) airglow line during two nights in February 1976 at Mt Abu[6]. It was later improved and made more sensitive by using larger plates and controlling the instrument by a single frequency He-Ne laser line at 6,328 Å. It was possible to measure the Doppler width of the 6,300 Å line to an accuracy of 1.5 mÅ with this arrangement. This corresponds to an accuracy in temperature measurements to within ± 70 K. Table 1 shows the data obtained on different nights, and the neutral atmospheric temperatures obtained from these measurements. The geomagnetic activity represented by the sum of *K*-indices is also given for each day at the end of the table. It is found that neutral atmosphere temperatures are 200–300 K higher than those calculated, assuming the atmospheric model of Jacchia[7] to account for the observed intensity of 6,300 Å oxygen line which was simultaneously recorded with a filter photometer at Mt Abu. In general, we found that the measured neutral atmospheric temperatures at the Mt Abu peak occur between 2000 and 2130 IST and do not seem to be directly associated with the geomagnetic activity. Spread-F activity, which normally starts on the equator after sunset, seems to be associated with these temperature increases. Unfortunately we do not have ionograms from Mt Abu, so the spread-F information is obtained from ionograms at Thumba, on the geomagnetic equator and in approximately the same meridian.

Table 1 Observed neutral atmosphere temperatures over Mt Abu, India

Time (IST)	Date 21.2.76	22.2.76	9.10.77	11.10.77	12.10.77	13.10.77
1930	892†	918†	‡	*	†	909*
2000	†	†	1,076‡	*	850†	*
2030	1,296†	1,210*	862‡	*	†	990*
2130	†	*	‡	1,245*	†	†
2230	*	850*	‡	*	†	†
2300	*	*	‡	1,192†	†	†
2315	865*	825*	‡	†	†	†
0030	†	900*	‡	†	†	†
Σ K-index	23	22	9	18	28	20

All temperatures measured in K.
*Spread-F present over Thumba.
†Spread-F absent over Thumba.
‡No data available on spread-F.

It is clear that the neutral atmospheric temperature at Mt Abu during equatorial spread-F occurrence at Thumba is 200–300 K higher than when there is no spread-F at Thumba and also higher than can be deduced from the accepted model atmosphere. These temperature enhancements imply a temperature gradient between the F and E region of the order of 1 K km^{-1}, the same as predicted by Cole. These observations are consistent with the model[4] of Cole for formation of spread-F on large-scale field-aligned irregularities between conjugate dynamo regions of the ionosphere and the estimates of heating in the spread-F events[1]. Thus, these results provide fairly unambiguous evidence that there is significant heating of the atmosphere above 300 km due to Joule dissipation of currents generated in the F-region by turbulent electric fields during spread-F events over and near the magnetic equator. A detailed paper on this topic will be published elsewhere.

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