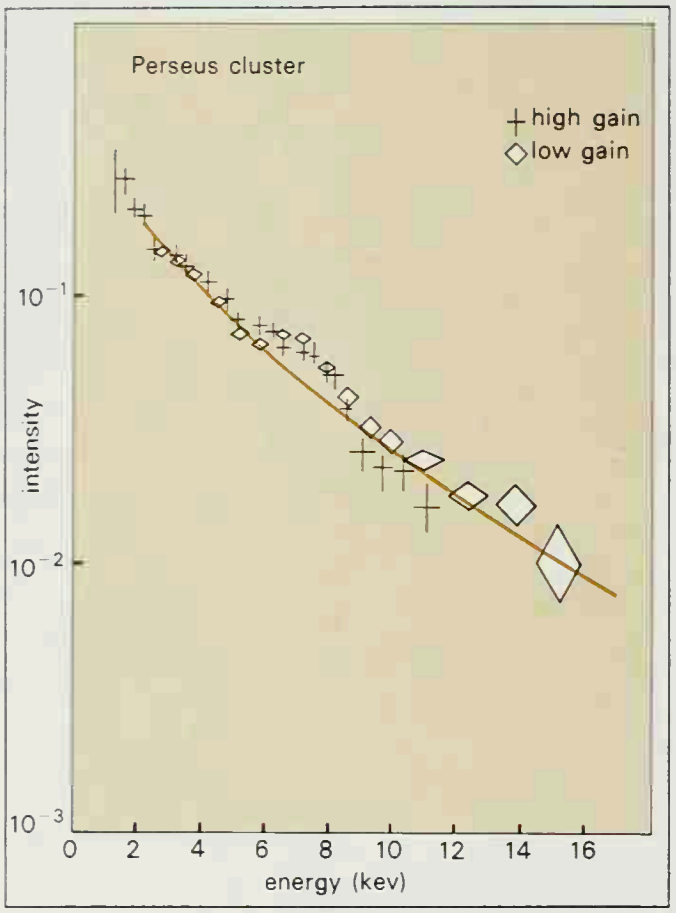

Fig. 7·7
X-ray spectrum of the Perseus cluster obtained by the Ariel V satellite.

emission is a very hot ionized gas or plasma lying in between the galaxies of the cluster, an intergalactic and intracluster gas, with a temperature of about 10^8 K and density about 100 electrons per m^3, for such a plasma would emit X-rays by the process of thermal bremsstrahlung (pages 200–201). An alternative suggestion, that there is an interaction between the observed background microwave radiation in the universe (page 206) and supposed very high speed electrons, seem much less probable.

In 1976, astronomers from University College London detected an X-ray spectral line feature at a wavelength of about 0·2 nm – just the emission to be expected from a hot plasma containing very highly-ionized iron atoms, atoms where twenty-four or twenty-five of the normal twenty-six electrons have been lost (Fig. 7·7). Not only does this observation support the idea of a hot intergalactic plasma, but the presence of iron suggests that the gas has been processed through nucleosynthesis in stars, since primaeval gas would contain only hydrogen and helium. It seems that the gas must have been ejected from galaxies within the cluster.

Superclusters

Clusters do not appear to be distributed at random, and this is generally interpreted as good evidence for a clustering of clusters, or a superclustering (Fig. 7·8). The Local Group is believed to be part of a supercluster of diameter about 75 Mpc centred on the Virgo cluster, and known as the **Local Supercluster**. Going further, there have even been suggestions of a clustering of superclusters and possibly even higher-order aggregations, but there is no clear evidence for these.

The problem of the 'missing mass'

The virial theorem which gives a method for determining the mass of a spherical distribution of stars can be used also to determine the mass of a cluster of galaxies. We have to know how velocity is distributed, and for stars in a galaxy this is derived using integrated starlight, but the galaxies in a cluster are studied individually. The mass deduced in this way can be compared with the total mass of all the galaxies in the cluster, but in every case studied the results disagree. The mass given by the virial theorem is larger than the sum of the masses of the galaxies, by a factor of about 8 for large regular clusters dominated by elliptical galaxies (such as the Coma cluster) and by more for some smaller clusters containing more spirals.

To examine this discrepancy it is necessary first to consider possible errors in the virial theorem mass determination. The value could be too large: if there were a significant number of pairs of galaxies much closer together than the average in the cluster, which

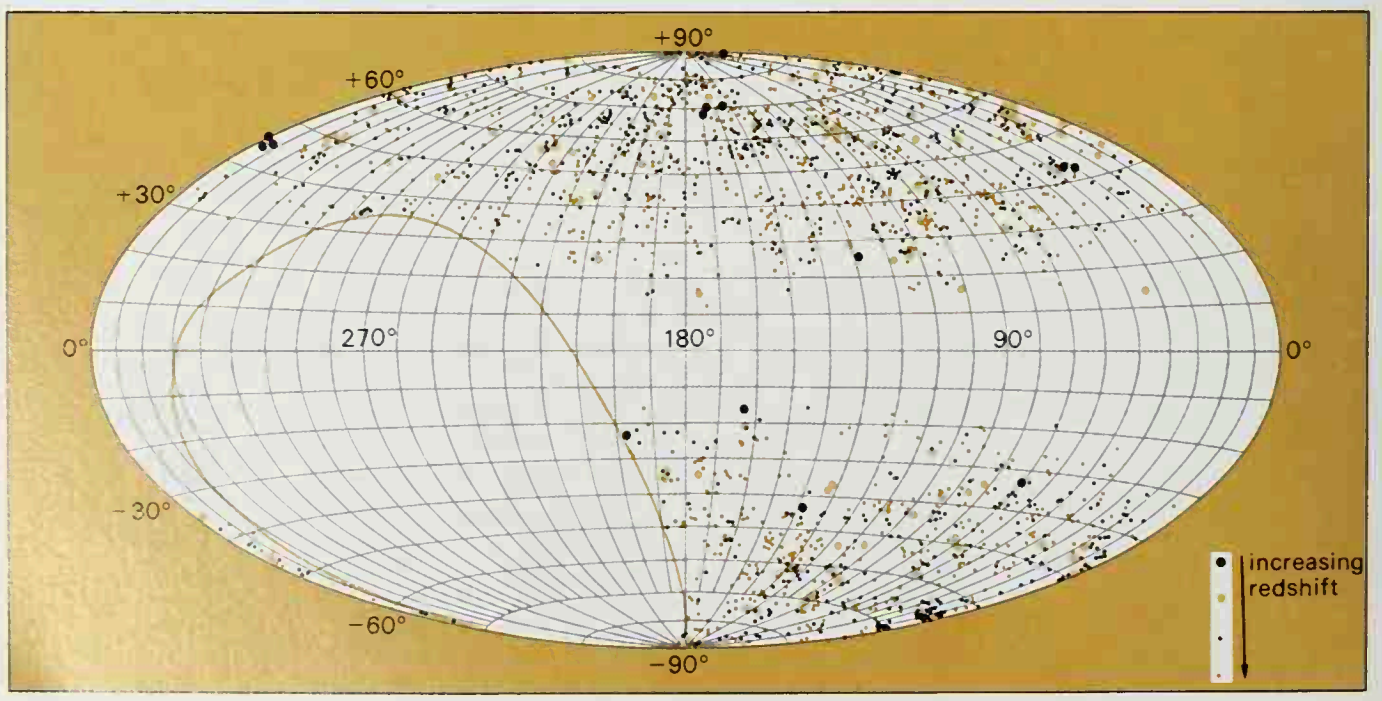

Fig. 7·8
The distribution of clusters of galaxies in the sky, plotted in galactic co-ordinates with the galactic anticentre near the centre of the plot. The large empty oval was not covered by this survey. Clusters show a clear tendency themselves to cluster together. Notice also the zone of avoidance on either side of the galactic plane (compare with Fig. 7·1 on page 192).