

of quantum physics and ionized plasmas (the world of subatomic particles). But for our purposes, the creation of the Universe can be divided into two basic eras: the radiation dominant era and the matter dominant era (see figure 3,1).

Radiation Dominant Era. The light or radiation dominant era began with the instant of creation and lasted for the first several hundred thousand years. It was characterized by extremely high temperatures and was dominated by energy radiation in the form of light. Energy radiation was so powerful that aggregations of matter were broken up and dispersed faster than they could form. Matter played only the role of a negligible contaminant, and the omnipresent light was so dense that it is best described as a luminous cloud of enormous brilliance.

Matter Dominant Era. The Universe continued to become cooler and less dense as the headlong flight of energy and unorganized matter continued outward into the void. At the temperature of about 3,000°C a striking transition occurred from a *radiation dominated* to a *matter dominated* Universe. Electrons joined with nuclei to form the first atoms of hydrogen and helium. The Universe became transparent and darkness again prevailed.

The enormous energy radiation of the early Universe had been lost by the shift of photon (light) wavelengths to the red end of the spectrum, leaving what was previously a minor contamination of nuclear particles and electrons to grow into vast cloud clumps of gases, then into galaxies of stars. As stars came into existence, they began to convert their hydrogen into helium in a kind of giant nuclear fusion reactor. The stars began to burn and shine with intense

FIGURE 3.2

The Andromeda Galaxy as seen from the Palomar Observatory. As viewed from Earth, this galaxy lies in a flat plane.

