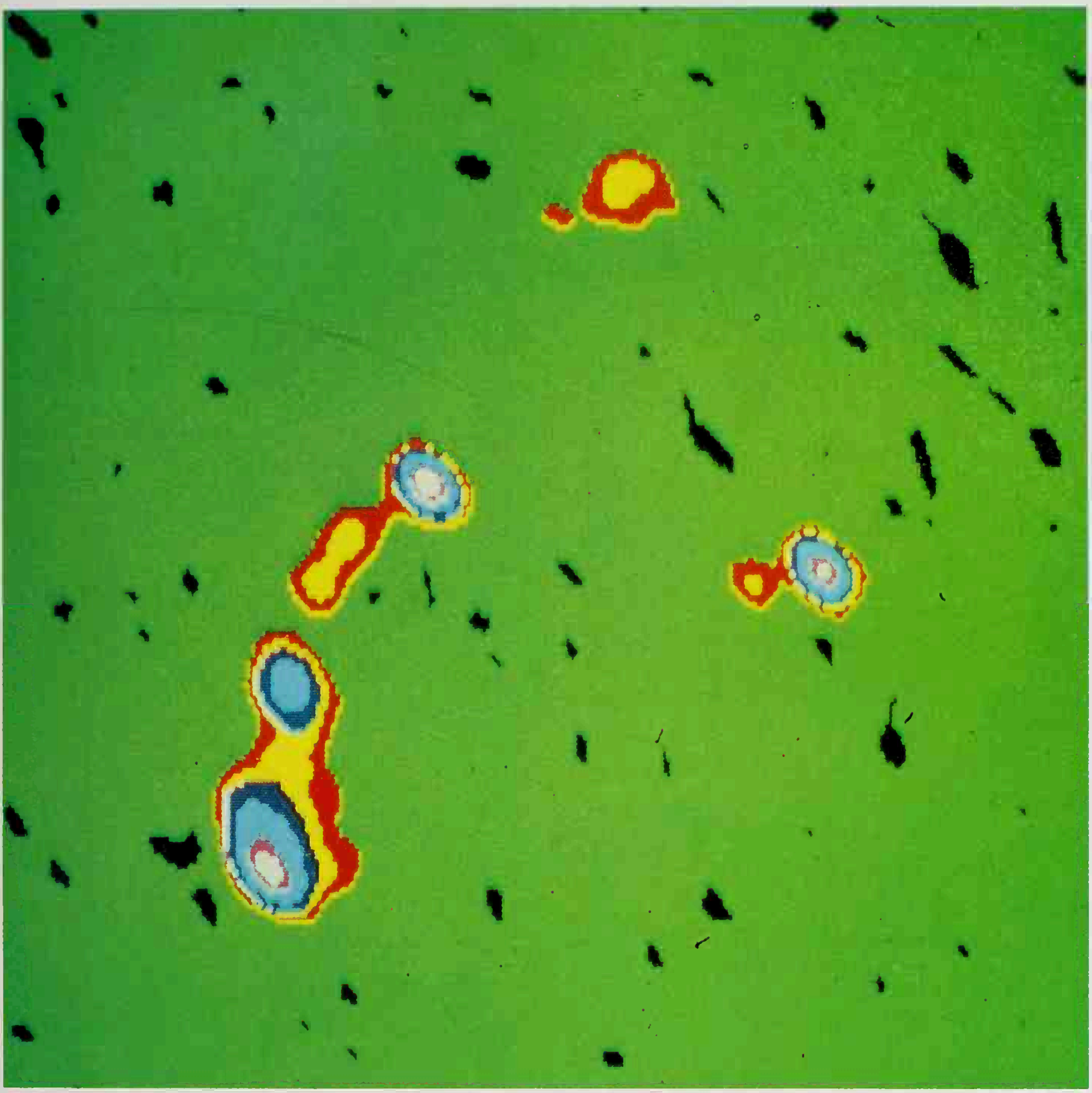

*The twin images of the quasar 0957 +561 shown in this radio 'picture' are the two ellipses in the centre. The galaxy which produces the gravitational lens effect (page 221) is invisible here, but is just above the lower twin. Calculation shows that the second images of the radio lobes* (left and right) *are too faint to be detected.*

The Schwarzschild model of the black hole is a stationary object, yet it is more probable that it rotates (Fig. 8·8). The mathematics of a rotating black hole are somewhat different from that of a stationary one and, in particular, the event horizon rotates and the hole is surrounded by a 'stationary limit', a spherical surface on which a body must travel at the speed of light if it is to appear to remain stationary. Although in theory nothing can escape from a black hole, recent research has shown that this may not be strictly true. Research by Stephen Hawking of Cambridge University, England, has shown that quantum theory leads to the idea that the whole of space is filled with virtual particles and their antiparticles, virtual particles being so-called because they can only be observed by their effects. Ordinarily, they combine with their antiparticles (that is, particles of the same kind but with an opposite electric charge) and both are annihilated, but Hawking has shown that in the presence of a black hole one of the pair may fall into the hole, leaving the other without a companion so it can not be annihilated. This companion may itself fall into the black hole, or it may escape; if the latter happens energy is removed from the black hole (Fig. 8·9). Calculation shows that few particles can be expected to escape from a very large black hole, because in such a hole the stationary limit is very close to the event horizon, but in a tiny black hole – one about the size of a proton and with a mass of $10^9$ tonnes – particles would stream out at a terrific rate, emitting energy equivalent to three nuclear power stations.

Hawking has found that a black hole will lose mass as it radiates energy, so that in due course it will evaporate away. Small black holes will vanish after a life of only $10^{10}$ years, but large ones may last as long as $10^{66}$ years. Since the universe, as we shall soon see, appears to be a few $10^{10}$ years old, and since the tiny black holes – if they do exist – would have been formed in the early stages of the universe, they should now be evaporating, emitting vast amounts of high energy $\gamma$-radiation as they do so. Such $\gamma$-radiation could be detected by orbiting spacecraft and from Earth because the $\gamma$-rays hitting our atmosphere will create a shower of electron-positron pairs in a kind of electromagnetic sonic boom.