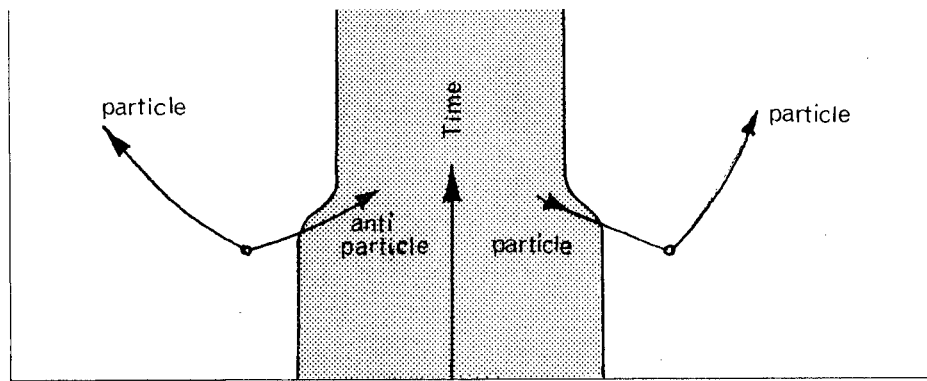


Two ways of looking at particle emission from black holes as a result of pair creation in the intense gravitational field near the event horizon. On the left, an antiparticle is sucked into the black hole while the particle escapes. Note that the boundary of the black hole shrinks as a result of the energy lost. On the right is a different way of looking at the same process, with a particle tunnelling out of the black hole backwards in time, but appearing finally as a conventional particle.



these gravitationally produced particles constitutes the temperature radiation of the black hole.

Simple arguments show that the temperature of an electrically neutral, non-rotating black hole depends inversely on its mass. This means that such a black hole has negative specific heat — as it radiates and loses energy (mass), it gets hotter and radiates faster, eventually evaporating away completely. Like a snowman melting in a sudden thaw and leaving no trace of its existence, such a black hole would disappear leaving no clue of the matter and radiation devoured in its lifetime.

Hawking concludes that the intrinsic uncertainty about the interior of black holes is as intimately linked with the underlying mechanisms of the Universe as is Heisenberg's Uncertainty Principle. This idea is now embodied in the 'Principle of Ignorance', implying that gravity imposes a new level of uncertainty or randomness into our picture of the Universe over and above that imposed by quantum mechanics. While Einstein himself found quantum mechanics sometimes hard to swallow, as epitomised by his famous maxim 'God does not play dice', Hawking now retorts saying that 'God not only plays dice, sometimes he throws them where they cannot be seen'.

While there are many potential astronomical candidates for black holes, none of them have yet been confirmed; Cygnus X-1 is currently the most likely contender for black hole honours. Nevertheless, the concepts continue to provide volatile fuel for theorists' imaginations. Hawking's new link between general relativity and quantum mechanics provides the first real example of a successful encounter between these two main avenues of theoretical approach. That the synthesis was achieved by introducing only thermodynamical arguments could point towards a radically new way of understanding.

More on dibaryons

Results coming from polarised proton experiments at Argonne have for some time been giving indications of a possible dibaryon resonance. Now a full partial wave analysis of the results gives strong evidence for a dibaryon resonance at 2260 MeV, with a width of 200 MeV, spin three and negative parity (as reported in the 'Around the Laboratories' section).

Only one dibaryon state — the deuteron — is well established, but some ten years ago in the heyday of group theory, Freeman Dyson and N.H. Xuong used the SU6 model to predict the existence of a series of different spin and parity dibaryon states as companions for the deuteron. The deuteron itself belongs in an SU3 decuplet in this model, while each additional dibaryon state has its own SU3 family.

In addition to the Argonne data, measurements of proton polarisation in deuteron photodisintegration experiments at Tokyo have also indicated the existence of a heavy dibaryon state, this time with spin three and positive parity, which is interpreted as a bound state of two baryon resonances. Other dibaryon evidence has been seen at Dubna, Berkeley and Rutherford.

Evidence for a dibaryon resonance was reported earlier this year by a CERN/Heidelberg/Munich collaboration (see May issue, page 152). This effect at 2129 MeV with spin one and positive parity is in the lambda-proton channel and corresponds to a unit strangeness state in the SU3 multiplet in which the deuteron, also with spin one and positive parity, forms the lowest-lying state.

While such experiments, using statistics of precise polarisation measurements, have only now begun to show signs of the existence of these

companions for the deuteron, additional dibaryon states could also exist as a result of quark 'bag' or 'string' forces.

The continuing ability of the naive quark model to predict particle properties, coupled with the continuing reluctance of the quarks to reveal themselves, has put physicists in a dilemma. One way out of this dilemma is the so-called 'bag model' which says that quarks exist permanently confined together. Normally these 'bags' which hold the quarks are the usual baryons and mesons, but additional bags could exist containing, for example, six quarks in a dibaryon system. Other models use 'strings' of gluons to confine the quarks (see June issue, page 199).

The attractive force between pairs of baryons (as in the deuteron) is the result of meson exchanges and is a relatively long-range effect compared with the sizes of the baryons themselves. In the bag or string-picture, the dibaryons are held together by short-range colour forces which give rise to whole new spectroscopies over and above those due to 'long range' interactions. These additional baryon of number 2 states could be detected in future experiments.