at the critical point, correlations extend over arbitrarily large distances, limited only by the size of the system. Usually the size of the constituents in these systems is at the atomic level. However, critical behaviour is also seen in so-called complex fluids, which are made up of relatively large molecules. Complex fluids offer the possibility of tracking individual particles while the external parameters are changed. Advances in visualization techniques for such mesoscopic objects have now enabled us to obtain a rather complete picture of the phase transition in a colloid–polymer system, as Patrick Royall and co-workers report on page 636 of this issue[1]. Fluctuations were captured both close to the critical point, where they happen on a large scale, and far away from it, where fluctuations take place on the single-particle level.

Methods, tools and theoretical schemes originally devised for atoms or small molecules have turned out to be of great value for much more complex systems such as polymers or colloidal particles in solution. Take, for example, globular proteins in aqueous solution. This is a terribly complicated system, with thousands of monomers forming each protein and a large number of small molecules — such as water, ions and co-ions — present in the solution. Still, a useful model of the system is obtained when each globular protein is treated as one 'effective particle': the overall effect of the direct interaction between the monomers of two neighbouring proteins, together with the indirect effects owing to the presence of the small molecules of the solvent, is reduced to one effective mutual interaction between the particles.

Complex fluids — such as the colloid–polymer suspension that Royall *et al.*[1] study — often display a phase transition in which two phases co-exist, one rich and one poor in the big particles. Also in this case, the phase transition ends at a critical point, analogous to a liquid–vapour transition (see Fig. 1). In such a transition, typically some attractive force between the particles is responsible for the condensation. In the suspension of Royall and colleagues[1], the attraction between two colloids is due to the osmotic pressure that the polymers exert on the colloids. The pressure becomes unbalanced when two colloids are sufficiently close, leading to depletion of polymers in between two colloids and to a mutual attraction. The intensity of the 'depletion interaction'[2] is controlled by the concentration of polymers, c_p. More precisely, $1/c_p$ has the role that the temperature has in the standard liquid–vapour transition. At large values of c_p, the system separates into two phases, one rich and one poor in colloids. By reducing c_p, the two phases become ever more similar until at a critical concentration all discontinuities disappear. Some earlier studies[3,4] have provided evidence of critical behaviour in a colloid–polymer mixture and in other complex fluids. But with their ability to look simultaneously at large-scale fluctuations and at the characteristics of single-particle clusters, Royall *et al.*[1] unveil a much more complete picture of the phase transition, and see behaviour that could aid our general understanding of the critical state.

When a given conceptual framework is applied to a different field from the one for which it was originally developed, one might hope that some new features will appear that extend our knowledge. This happened in the case of some complex mixtures from which we learned that the standard tenet of the sequence of

NUCLEAR ASTROPHYSICS

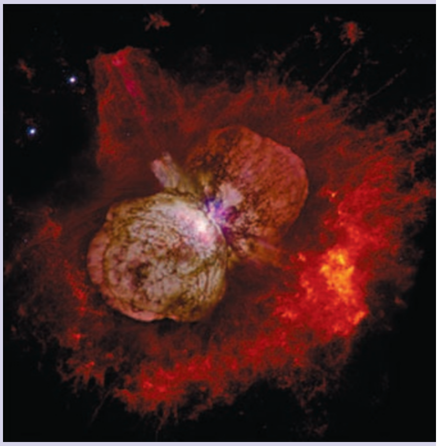
Among the super brilliant

A landmark paper in nuclear astrophysics turns 50 next month. Written by Margaret Burbridge, Geoffrey Burbridge, Willy Fowler and Fred Hoyle — now referred to as 'B^{2}FH' — the paper showed that all of the elements from carbon to uranium can be created inside stars using hydrogen and helium produced from the Big Bang (*Rev. Mod. Phys.* **29,** 547–650; 1957). Alongside work by Al Cameron, it brought stellar nucleosynthesis to the fore in astrophysics. Synthesized elements are spread through space when a star ends its life in a spectacular explosion, or supernova, and with each supernova discovery — now hundreds each year — some aspect of the current models for nucleosynthesis is tested and refined.

Certain supernovae stand out. SN 1987A, the first supernova that was observed in 1987, was the brightest in 400 years. As well as being the first supernova to be confirmed as a source of neutrinos, its progenitor star turned out to be a blue supergiant instead of an assumed red one. Then came SN 1993J, which was unusual in that it underwent significant mass loss before the explosion. And SN 2004dj provided more direct evidence for a non-spherical explosion that might be generic to type-II supernovae.

In 2006 appeared SN 2006gy, the brightest supernova ever recorded. It took 70 days to reach peak luminosity, when it shone brighter than 50 billion Suns, and remained more luminous than any known supernova for more than 100 days. Nathan Smith and co-workers propose that radioactive decay of ^{56}Ni may be responsible for the brightness, although the amount of ^{56}Ni required exceeds what is allowed in the usual core-collapse model (*Astrophys. J.*, in the press; preprint at <http://arxiv.org/abs/astro-ph/0612617>; 2007). Instead, they consider a pair-instability supernova from a massive progenitor star, one with a mass more than 100 times greater than that of the Sun.

In such a high-mass star, core gamma rays with energy greater than the rest mass of two electrons would be able to create electron–positron pairs, setting up a feedback loop that effectively heats the core and generates more high-energy gamma rays and, therefore, more pairs. This mechanism would concentrate energy at the core until the outer layers collapse inwards; the resulting compression would start a thermonuclear explosion of the core. The ensuing blast obliterates the star, leaving no black hole behind. The authors suggest that the progenitor star would be similar to η Carinae (pictured) in our own Galaxy, which could go nova at anytime.



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