Editorial

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The theme we feature in this issue is that of phase transitions, centred around the seminal contributions of Leo Kadanoff. The development of the modern theory of phase transitions and critical phenomena is a celebrated chapter in the history of statistical mechanics in the twentieth century. Its heyday is now half a decade away, with major advances taking place in the sixties and early seventies. The classic work of Kadanoff reproduced here, with an introduction by Rajaram Nityananda, is dated, coincidentally, 1966; this year could well be celebrated as the golden jubilee of this publication. Leo Kadanoff is introduced to the readers of this issue by a warm and personal account by Sabyasachi Bhattacharya, who interacted with Kadanoff at the University of Chicago at a time when Kadanoff was a well established scientist, and a mentor to younger colleagues around him. The stimulating ambience of the group that gathered around Kadanoff, and his role as an intellectual leader and a caring mentor for the younger members, are portrayed engagingly, along with a brief biography and summary of Kadanoff's scientific accomplishments.

Phase transitions are a matter of common experience on earth. The most familiar example perhaps is the boiling of water, and freezing of water in colder climates. Commonplace as they are, they should be objects of wonder. Isn't it amazing that the same substance – water – can be contained in a glass (as a liquid) but yield to the smallest applied force (when we tilt the glass even slightly), or exist in a form that is (literally) nebulous and hard to contain (as vapour) or be solid and hard as stone (as ice), all within a span of a hundred degrees of change in temperature! Life as we know it, depends on these changes of form, and indeed the rather special circumstance (as depicted on the cover page) that water can exist in these different forms within the range of conditions that prevail on earth. The phrase "walking on water" connotes a miraculous deed, something that only *siddhas* and prophets can manage. But on a typical winter day in an Arctic country (e.g., Iceland), it is the easiest thing to do! It does need a miracle however – that water so dramatically change its behaviour when temperature falls below zero.

There are of course, many kinds of phase transitions well-known and esoteric, exhibited by matter in diverse conditions: magnets, superfluids, superconductivity, liquid crystals, polymers, quarks, gluons and neutron stars, in addition to the familiar liquids, gases and solids. Their systematic study dates back at least to the nineteenth century: the liquefaction of gases, including those once thought to be 'permanent gases' (like the constituents of air), the van der Waals equation of state, studies of magnetism in the early twentieth century, discoveries of superfluidity and superconductivity, the development of Landau theory, are some landmarks. A special focus in the period preceding Kadanoff's was on the liquid-gas critical point and (by hindsight) its analogs. The change in density that marks the transition from liquid to gas decreases as the temperature of observation increases, till the distinction ceases at a special temperature, and a corresponding pressure, referred to as the critical point. At this point, one observes heterogeneities in density on all length scales. The behaviour, around from the critical point, exhibits striking features that are the same or universal for a wide range of materials, and indeed many different kinds of transitions. Kadanoff's insights in analysing such behaviour, and the associated, far reaching notions of scaling and renormalization, are described in the article 'Scaling concepts in describing continuous phase transitions'. These concepts have found wide ranging applications beyond phase transitions, in diverse contexts in statistical physics (e.g., describing time-dependent processes), particle physics and field theory, polymer physics, and much beyond, some of which will be described in future editions of *Resonance*.

This issue also features articles on other topics ranging from DNA repair and separation of granular materials to neutrino oscillations, and the search for other earth-like planets. As this issue goes to the press, NASA announced new findings on Europa, a moon of Jupiter, showing evidence of plumes of water vapour. This suggests an opportunity for flyby missions to collect samples of vapour to gain better knowledge of the ocean that is suspected to lie beneath its frozen ice-crust. An exciting episode in the quest for earth-like planetary settings and extra-terrestrial life may be in the offing, aided by the opportune occurrence of phase transitions that will give us a glimpse of what lies beneath the surface!