Editorial

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A beautiful picture of *Bonnet Macaque*, the 'common performing monkey' of southern India, greets you on the coverpage of this issue of *Resonance*. Two things are recalled to the mind with monkeys: *ceaseless activity* and a *tendency towards disorder*. It is, perhaps, appropriate since this issue celebrates Ludwig Eduard Boltzmann (1844-1906), one of those pioneers who showed us how to formulate and study the concept of disorder and how ceaseless activity of the individual molecules explains the macroscopic laws of thermodynamics.

Sriram Ramaswamy sets the stage for this *Boltzmann issue* with brief sketch of life and work of Boltzmann. Boltzmann apparently believed more in repeating himself frequently in the interest of clarity and at the cost of 'elegance' which resulted in long (and in the opinion of many physicists, bad) papers. Boltzmann seems to have been aware of this criticism as is apparent from Einstein's statement in his book on Relativity (1916):

"In the interest of clearness, it appeared to me inevitable that I should repeat myself frequently, without paying the slightest attention to the elegance of the presentation. I adhered scrupulously to the precept of that brilliant theoretical physicist L Boltzmann, according to whom matters of elegance ought to be left to the tailor and the cobbler."

During Boltzmann's time atomic theory of matter had not been fully accepted. There were heated debates and arguments, personal attacks not excluded, between the 'energists' and the 'atomists. These attacks upset Boltzmann and resulted in his frequent shifting of universities in an effort to avoid having 'energists' as colleagues.

On the other hand there were some theoretical objections to Boltzmann's proof of the increase of entropy. Principal one among them was the 'reversibility paradox' pointed out by Loschmidt, an atomist who gave an estimate of the molecular size using the kinetic theory of gases. Boltzmann realised the importance of the need for a proper understanding of the second law of thermodynamics and succeeded in deriving the second law of thermodynamics from the mechanical/statistical laws governing aggregates of molecules. It ultimately led him to his famous expression for entropy which, in accordance with his wishes, adorns his grave in Vienna's Central Cemetery.

As to his motivations for pursuing science instead of taking up more socially highly regarded jobs he replied:

It must be splendid to command millions of people in great national ventures, to lead a hundred thousand to victory in battle. But it seems to me greater still to discover fundamental truths in a very modest room with very modest means – truths that will still be foundations of human knowledge when the memory of these battles is painstakingly preserved only in the archives of the historian.

Articles in this issue look at the role of *entropy* in different subjects. Jayanta Bhattacharjee describes the concept of entropy as it was propounded in Boltzmann's work on thermodynamics. Rajaram Nityananda's article explains the development of a similar phenomenon in probability theory. This culminated in the introduction of the concept of entropy of a probability distribution by Claude Shannon (1916-2001) in 1948 which heralded the subject of *Information Theory*. This aspect has been dealt with in the article by S Natarajan whose interest in this subject was aroused by an earlier article in *Resonance*!

Boltzmann was not far off when he said that the next century, i.e., the 20th century, belonged to Darwin; may be he also foresaw the role entropy would play in biology, a world in which order is built out of disorder. Jayant Udgaonkar discusses the role of entropy in biology. Binny Cherayil tells us how entropy helps in determining in which direction a natural change is likely to take place.

Thermodynamics owes its origin to the engineers who strove to manufacture more and more efficient engines to convert heat energy into mechanical energy. Ananth and Ravi describe the role of entropy in the chemical industry.

Though the sky was usually overcast and it was raining frequently there were occasions when the night sky was clear affording a glorious view of the Scorpius and Saggitarius regions. We hope readers will use the sky charts provided in these issues and write to us their experiences and questions.

Measure what is measurable, and make measurable what is not so.

Quoted in I Gordonand and S Sorkin,
The Armchair Science Reader (New York, 1959)