Vibrational Spectrum of Spider-Web Networks

Deepak Dhar*

Department of Theoretical Physics, Tata Institute of Fundamental Research, 1 Homi Bhabha Road, Mumbai 400 005, India.

Ajit C. Balram[†]

Department of Physics, Indian Institute of Science Education and Research, Sai Trinity Building, Garware Circle, Sutarwadi, Pashan, Pune 411 021, India

A $2^N \times M$ - node spider network graph consists of M-levels each of which has 2^N vertices. Each vertex in the *m*-th level is connected to two vertices each in the $(m \pm 1)$ th levels. These graphs were introduced first for constructing switching networks for telephones. We consider a spring network on this graph. We use the large symmetry group of the graph to determine all normal models and their frequencies. In the limit of large M and N, the spectrum is a sum of δ -functions, and all the modes are localized. The fractional number of modes with frequency less than ω varies as $\exp(-1/\omega)$ for ω tending to zero. for the related problem of a random walker on this network, we study the probability of returns to the origin. We show that the probability that the walker returns to origin after n steps varies as $\exp(-n^{1/3})$ on this network.

I. BIOGRAPHICAL SKETCH

D. Dhar obtained his B.Sc. degree from Univ. of Allahabad in 1970, M.Sc. (Phys.) from I. I. T. (Kanpur) in 1972, and Ph.D. in Physics from Calif. Inst. of Tech. in 1978. He has been at Tata Institute of Fundamental Research, Mumbai since 1978. His research is the general area of statistical physics. In particular, he has worked on percolation and animal problems, glasses and slow relaxation to equilibrium, and self-organized criticality.

^{*}Electronic address: ddhar@theory.tifr.res.in

 $^{^{\}dagger} Electronic address: cb.ajit@gmail.com$