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Ground state and glass transition of the RNA secondary structure[1]

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RNA molecules form a sequence-specific self-pairing pattern at low temperatures. Understanding the relevant energy scales that govern sequence specificity is important for thermal and mutational stability studies of functional RNAs. This problem has been analyzed using a random pairing energy model as well as a random sequence model that includes a base stacking energy in favor of helix propagation [1]. The free energy cost for separating a chain into two equal halves offers a quantitative measure of sequence specific pairing [2]. In the low temperature glass phase, this quantity is shown to grow quadratically with the logarithm of the chain length, but it switches to a linear behavior of entropic origin in the high temperature molten phase. Numerical studies of the melting transition suggest similarities to the thermal depinning of a two-dimensional elastic manifold in a disordered medium, though details of the analogy need to be further explored. For designed sequences, however, a power-law distribution of pairing energies on a coarse-grained level may be more appropriate. Extreme value statistics arguments then predict a power-law growth of the free energy cost to break a chain, in agreement with numerical simulations. Interestingly, the distribution of pairing distances in the ground state secondary structure follows a remarkable power-law with an exponent 4/3, independent of specific assumptions for the base pairing energies.

[1] Sheng Hui and Lei-Han Tang, Eur. Phys. J. B **53**, 77 (2006).
[2] R. Bundschuh and T. Hwa, Phys. Rev. Lett. **83**, 1479 (1999); Phys. Rev. E **65**, 031903 (2002).

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