1063-60-186 **Allan Sly*** (allansly@microsoft.com), Theory Group, Microsoft Research, One Microsoft Way, Redmond, WA 98052. *Statistical physics and computational phase transitions of the hardcore model.*

The hardcore model is a model of lattice gas systems which has received much attention in statistical physics, probability theory and theoretical computer science. It is the probability distribution over independent sets I of a graph weighted proportionally to $\lambda^{|I|}$ with fugacity parameter λ. We prove that at the uniqueness threshold of the hardcore model on the d-regular tree, approximating the partition function becomes computationally hard on graphs of maximum degree d.

Specifically, we show that unless NP=RP there is no polynomial time approximation scheme for the partition function (the sum of such weighted independent sets) on graphs of maximum degree d for fugacity $\lambda_c(d) < \lambda < \lambda_c(d) + \epsilon(d)$ where

$$\lambda_c = \frac{(d-1)^{d-1}}{(d-2)^d}$$

is the uniqueness threshold on the d-regular tree. Weitz produced an FPTAS for approximating the partition function when $0 < \lambda < \lambda_c(d)$ so this result demonstrates that the computational threshold exactly coincides with the statistical physics phase transition thus confirming a conjecture of Mossel, Weitz and Wormald. Our proof is based on an analysis of the hardcore model on random bi-partite graphs which act as gadgets in a reduction to MAX-CUT. (Received August 16, 2010)