

## Mathematical Physics

# On $p$ -adic Gibbs Measures for Hard Core Model on a Cayley Tree

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In this paper we consider a nearest-neighbor  $p$ -adic hard core (HC) model, with fugacity  $\lambda$ , on a homogeneous Cayley tree of order  $k$  (with  $k + 1$  neighbors). We focus on  $p$ -adic Gibbs measures for the HC model, in particular on  $p$ -adic "splitting" Gibbs measures generating a  $p$ -adic Markov chain along each path on the tree. We show that the  $p$ -adic HC model is completely different from real HC model: For a fixed  $k$  we prove that the  $p$ -adic HC model may have a splitting Gibbs measure only if  $p$  divides  $2^k - 1$ . Moreover if  $p$  divides  $2^k - 1$  but does not divide  $k + 2$  then there exists unique translational invariant  $p$ -adic Gibbs measure. We also study  $p$ -adic periodic splitting Gibbs measures and show that the above model admits only translational invariant and periodic with period two (chess-board) Gibbs measures. For  $p \geq 7$  (resp.  $p = 2, 3, 5$ ) we give necessary and sufficient (resp. necessary) conditions for the existence of a periodic  $p$ -adic measure. For  $k = 2$  a  $p$ -adic splitting Gibbs measures exists if and only if  $p = 3$ , in this case we show that if  $\lambda$  belongs to a  $p$ -adic ball of radius  $1/27$  then there are precisely two periodic (non translational invariant)  $p$ -adic Gibbs measures. We prove that a  $p$ -adic Gibbs measure is bounded if and only if  $p \neq 3$ .

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