Quantum memory on topological spin glass  
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Watson Research Center — We show that any topologically ordered local stabilizer  
model of spins in three dimensional lattices that lacks string logical operators can be  
used as a reliable quantum memory against thermal noise. It is shown that any local  
process creating a topologically charged particle separated from other particles by a  
distance $R$ must cross an energy barrier of height $c \log R$. This property makes the  
model glassy. We devise an efficient decoding algorithm that should be used at the  
final read-out, and prove a lower bound on the memory time until which the fidelity  
between the outcome of the decoder and the initial state is close to 1. The memory  
time increases as $L^{c \beta}$ where $L$ is the system size and $\beta$ the inverse temperature,  
as long as $L < L^* \sim e^{\beta}$. Hence, the optimal memory time scales as $e^{c \beta^2}$. Our  
bound applies when the system interacts with thermal bath via a Markovian master  
equation. We give an example of a strictly local stabilizer code that satisfies all of  
our assumptions. We numerically verify for this example that our bound is tight up  
to constants.