## March 7, 2023

## Abstract

Notes

## 1 Hessian for $E(\theta_{ij}, \phi_{ij})$

$$E = -J1/2 \sum_{ij} \vec{S}_{i,j} \vec{S}_{i+1,j} + \vec{S}_{i,j} \vec{S}_{i,j+1} + J2/2 \sum_{ij} \vec{S}_{i,j} \vec{S}_{i+1,j+1} + J4/2 \sum_{ij} \vec{S}_{i,j} \vec{S}_{i+2,j} + \vec{S}_{i,j} \vec{S}_{i,j+2}$$

$$a_{11} = \begin{pmatrix} \frac{\partial^2 E}{\partial \theta_{11}^2} & \frac{\partial^2 E}{\partial \theta_{11} \partial \phi_{11}} & \frac{\partial^2 E}{\partial \theta_{11} \partial \theta_{12}} & \frac{\partial^2 E}{\partial \theta_{11} \partial \phi_{12}} & \frac{\partial^2 E}{\partial \theta_{11} \partial \phi_{13}} & \frac{\partial^2 E}{\partial \theta_{11} \partial \phi_{13}} & \frac{\partial^2 E}{\partial \theta_{11} \partial \phi_{14}} & \frac{\partial^2 E}{\partial \phi_{11} \partial \phi_{14}} & \frac{\partial^2 E}{\partial \phi_{12} \partial \phi_{13}} & \frac{\partial^2 E}{\partial \phi_{12} \partial \phi_{13}} & \frac{\partial^2 E}{\partial \phi_{12} \partial \phi_{14}} & \frac{\partial^2 E}{\partial \phi_{12} \partial \phi_{13}} & \frac{\partial^2 E}{\partial \phi_{12} \partial \phi_{13}} & \frac{\partial^2 E}{\partial \phi_{12} \partial \phi_{14}} & \frac{\partial^2 E}{\partial \phi_{12} \partial \phi_{13}} & \frac{\partial^2 E}{\partial \phi_{13} \partial \phi_{13}} & \frac{\partial^2 E}{\partial \phi_{13} \partial \phi_{14}} &$$

$$a_{44} = \begin{pmatrix} \frac{\partial^2 E}{\partial \theta_{31}^2} & \frac{\partial^2 E}{\partial \theta_{31} \partial \theta_{31}} & \frac{\partial^2 E}{\partial \theta_{31} \partial \theta_{32}} & \frac{\partial^2 E}{\partial \theta_{31} \partial \theta_{32}} & \frac{\partial^2 E}{\partial \theta_{31} \partial \theta_{33}} & \frac{\partial^2 E}{\partial \theta_{31} \partial \theta_{33}} & \frac{\partial^2 E}{\partial \theta_{31} \partial \theta_{34}} & \frac{\partial^2 E}{\partial \theta_{32} \partial \theta_{34}} & \frac{\partial^2 E}{\partial \theta_{32} \partial \theta_{34}} & \frac{\partial^2 E}{\partial \theta_{31} \partial \theta_{34}} & \frac{\partial^2 E}{\partial \theta_{31} \partial \theta_{34}} & \frac{\partial^2 E}{\partial \theta_{32} \partial \theta_{34}} &$$