Activity Report 13:30~15:30

HATANO LAB.

[Non-Hermitian Analysis of Neural Networks]

Department of Fundamental Engineering

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Many-Body Physics

Department of Physics

Non-Hermitian Analysis of Neural Networks

Neural networks have synapses that activate neurons and those that suppress them (Fig. 1). The matrix that represents such a network becomes asymmetric. As a simple example, let us consider the following real asymmetric matrix:

$$M = \begin{pmatrix} & +e^{-g} & & & & & \\ -e^{+g} & & -e^{-g} & & & & \\ & +e^{+g} & & -e^{-g} & & & \\ & & +e^{+g} & & +e^{-g} & & \\ & & & -e^{+g} & & -e^{-g} & \\ & & & & +e^{+g} & & +e^{-g} \\ & & & & & -e^{+g} & \end{pmatrix}$$

There are three rules here: (1) only the elements below and above the diagonal are nonzero; (2) the absolute value of the former is e^{+g} , while that of the latter is e^{-g}; (3) the sign of each element is randomly chosen.

The eigenvalue distribution of the matrix is fantastically fractal as shown in Figs. 2 and 3. We can analyze functions of the neural network from this distribution.

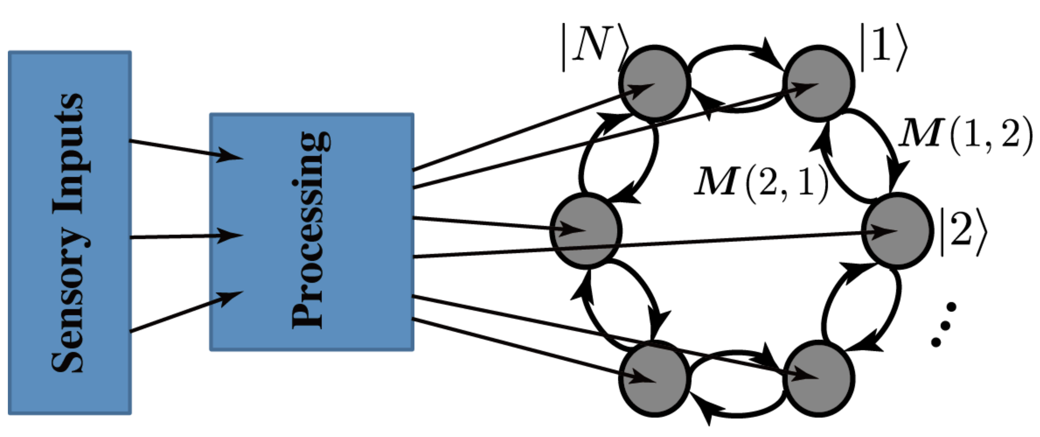

Fig.1. A simple mathematical model of a neural network.

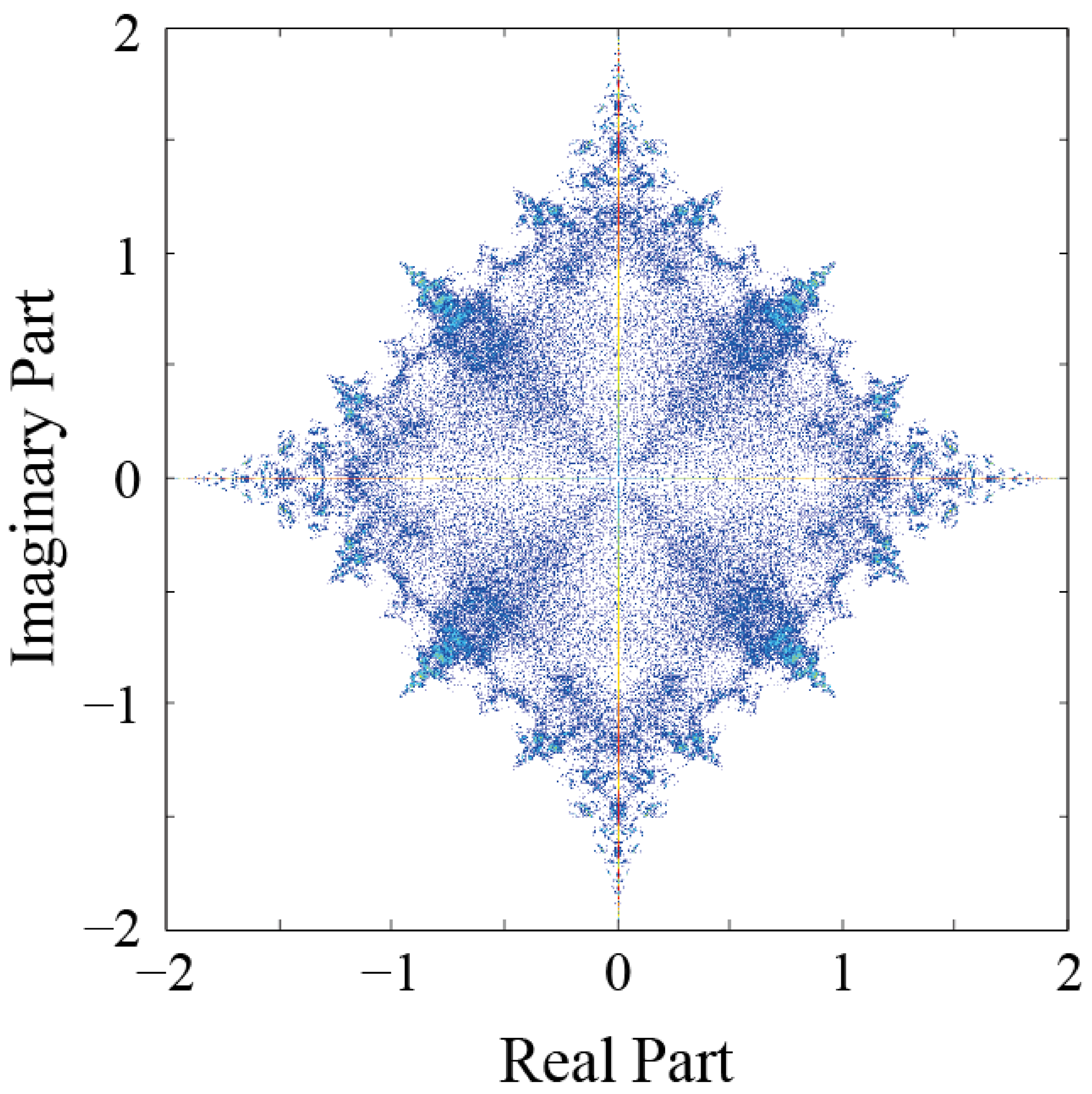

Fig.2. Eigenvalue distribution for $g = 0$

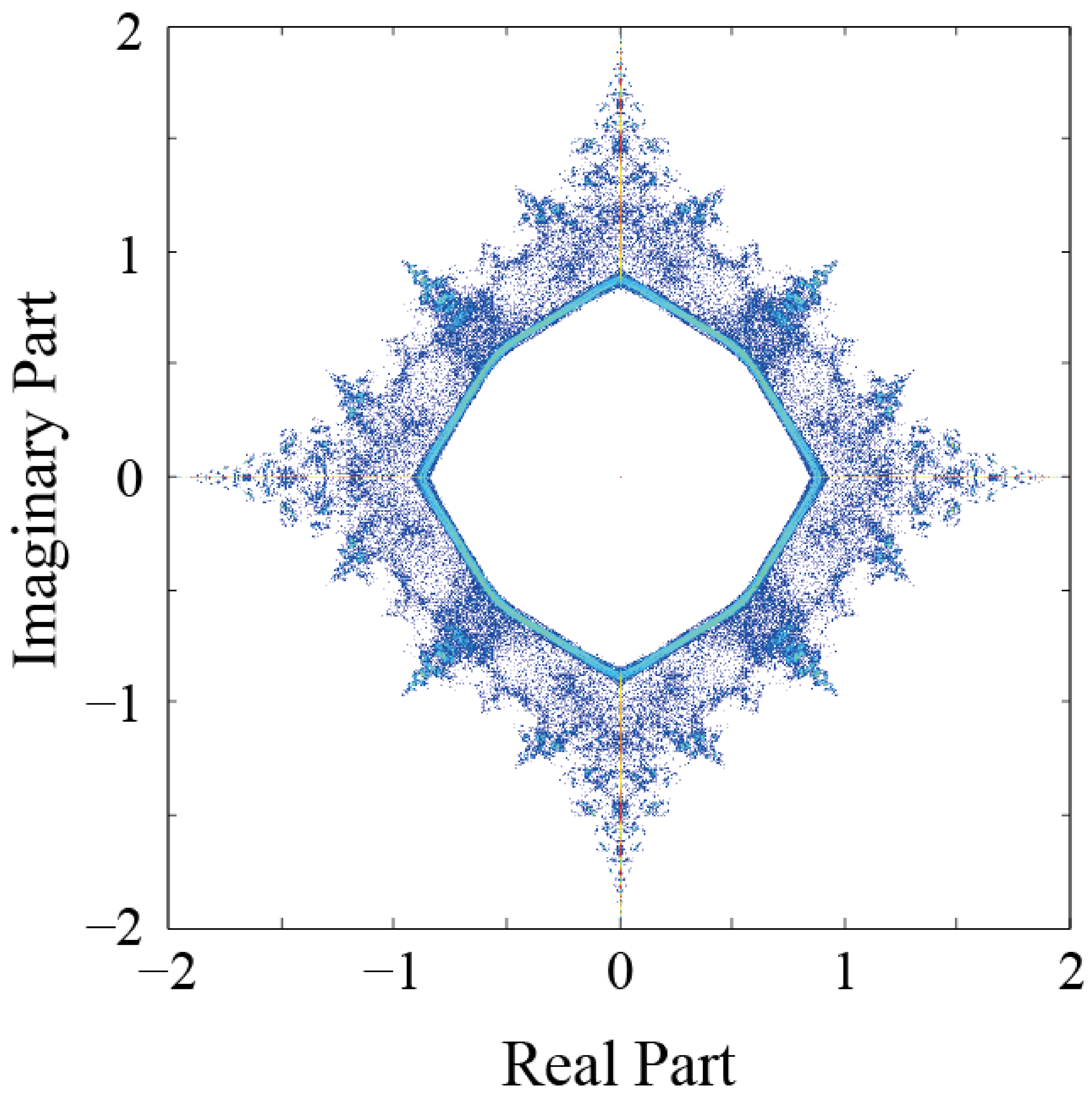

Fig.2. Eigenvalue distribution for $g > 0$