SD4551（学校用）

様式 A-1
(FY2024)

2024年　12月　20日

サイエンス・ダイアログ　実施報告書

1. 学校名・実施責任者氏名：さいたま市立大宮北高等学校・福井 伸之

2. 講師氏名：Dr. Fei YUN

3. 講義補助者氏名：なし

4. 実施日時：2024 年 12 月 11 日（水）　13：30 ～ 15：30

5. 参加生徒：1年生 7人、 2 年生 8 人、 ＿年生 ＿人（合計 15 人）
　備考：（例：理数科の生徒） 校内英語プログラムへの参加者の一部

6. 講義題目：The Exciting Physics of Flipping Tables
　(the subtitle: The fascinating connection between neurons and magnetism)

7. 講義概要：光工学についての講義および器具の使用と用途をまじえた実験

8. 講義形式：
☒対面 ・ □オンライン （どちらか選択ください。）
　1) 講義時間 110 分（実験を含む）　質疑応答時間 ＿＿分

　2) 講義方法（例：プロジェクター使用による講義、実験・実習の有無など）
　プロジェクター使用による講義、実験・実習も有り

　3) 事前学習
　有 ・ [✓ 無] （どちらかに〇をしてください。）
　使用教材 ＿＿＿＿

9. その他特筆すべき事項：
　特になし

SD4551

Form B-2
(FY2024)
Must be typed

Date（日付）
21/12/2024 （Date/Month/Year：日/月/年）

Activity Report -Science Dialogue Program-

（サイエンス・ダイアログ 実施報告書）

- Fellow's name（講師氏名）: FEI YUN （ID No. P22740）

- Name and title of the lecture assistant（講義補助者の職・氏名）

- Participating school（学校名）: Omiya Kita High School

- Date （実施日時）: 11/12/2024 （Date/Month/Year:日/月/年）

- Lecture title（講義題目）:
The Exciting Physics of Flipping Tables (The fascinating connection between neurons and magnetism

- Lecture format（講義形式）:
◆☒Onsite ・ ☐Online (Please choose one.)（対面 ・ オンライン）（（どちらか選択ください。））
◆Lecture time（講義時間） 90 min（分）, Q&A time（質疑応答時間） 30 min（分）
◆Lecture style（ex.: used projector, conducted experiments）
（講義方法（例：プロジェクター使用による講義、実験・実習の有無など））
30 min lecture projector, 30 min experiment, 30 min projector 30min experiment

- Lecture summary（講義概要）: Please summarize your lecture within 200-500 words.

In this lecture, we explored the fascinating intersection of physics and artificial intelligence, focusing on the Ising model and its connections to the Hopfield network. Using the playful metaphor of "flipping tables," we broke down complex ideas into accessible concepts for high school students. The Ising model, a foundational framework in statistical physics, has inspired computational models like the Hopfield network, a tool in neuroscience and AI. This topic is especially relevant given that the 2024 Nobel Prize in Physics was awarded for advancements in this area. Both models share key principles, including binary states, energy minimization, and the ability to describe dynamic systems.

We began with a simple and engaging introduction to linear algebra concepts, skipping heavy mathematical notation and instead using a game of lasers and mirrors. This activity laid the groundwork for understanding systems with multiple states. From there, we introduced the concepts of heat, thermal energy, and entropy, incorporating hands-on experiments. A Stirling engine was used to vividly demonstrate that heat is a form of energy, providing a tangible and memorable illustration.

To deepen this understanding, we observed demonstrations of magnetization and demagnetization driven by heat, leading to a discussion of the Curie temperature. With this foundation, we constructed a physical model using ping pong balls to represent atoms, offering students a clear visualization of what happens at the atomic level when materials are heated. This hands-on activity allowed students to develop an intuitive grasp of these phenomena.

Next, we delved into the Ising model itself. Using an approachable physical model, we illustrated how spins flip between states, driven by interactions with their neighbors and external factors. Students engaged in a game simulating the Ising model, gaining insights into how systems evolve toward stable, low-energy configurations.

Building on these ideas, we transitioned to the Hopfield network. By introducing the concept of a weighted matrix, we demonstrated how patterns are stored and retrieved in a network, highlighting the parallels between energy minimization in the Ising model and associative memory in the Hopfield network. We also discussed how probabilistic extensions of these models underpin modern neural networks, such as those used in natural language processing through tokenization and probabilities.

The lecture concluded with a practical and creative Q&A session. Students built DIY spectrometers using paper and CDs, learning about spectroscopy—a technique fundamental to science and a key application area for such models in my own research. This interactive activity provided a fun and engaging way to link theoretical models to real-world applications.

By the end of the session, students had seen how flipping spins in the Ising model or neurons in the Hopfield network leads to stable, ordered configurations. This interdisciplinary approach revealed shared principles between physics and AI, offering a compelling framework for understanding both natural and artificial systems. Students left with a deeper appreciation of how these ideas connect and apply across different domains.

◆Other noteworthy information（その他特筆すべき事項）:

- Impressions and comments from the lecture assistant（講義補助者の方から、本プログラムに対する意見・感想等がありましたら、お願いいたします。）:

WHAT IS HEAT?
DEMONSTRATION

Sadi Carnot

Thermal Energy