

# Joon-Young Moon

Assistant Research Scientist,  
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## Personal

South Korean Citizen  
United States of America Permanent Resident

## Research Keywords

Computational Brain Science, EEG/ECoG and fMRI Data Analysis, Brain State Transitions and Control, Brain Dynamics Modeling, Neural Correlate of Consciousness, Human General Anesthesia, Emergence in Complex Systems, Complex Networks, Nonlinear Dynamics and Chaos, Statistical Mechanics

## Education

Ph.D. Physics, POSTECH, 2/2012. Supervisor: Seunghwan Kim  
Thesis Title: Measuring Fractal Dimension of Complex Networks

M.A. Physics, POSTECH, 2/2005. Supervisor: Seunghwan Kim  
Thesis Title: Student Network of POSTECH based on Class Registration Data

B.S. Physics, Pohang University of Science and Technology (POSTECH), 2/2003

## Employment and Research Experience

Oct. 2017-, Johns Hopkins University: Asst. Research Scientist

Jul. 2012-Oct. 2017, University of Michigan: Research Fellow

Feb. 2012-Jun. 2012, POSTECH: Research Fellow

Apr. 2005-Feb. 2010, POSTECH: Technical Research Personnel as Alternative Military Service for Korea

Mar. 2004-Feb. 2005, Sep. 2005-Feb. 2012, POSTECH: Research Assistant

## Teaching Experience (\*\*best teaching assistant award)

Feb.-Jun. 2019, Dept. of Psychological & Brain Sciences, Johns Hopkins University: Organizer/Lecturer for Workshop on Information Flow in the Brain Networks

Jun.-Jul. 2018, Computational and Cognitive Neuroscience Summer School (CCNSS) 2018: Tutor/Instructor

2007-2011, Pocheol High School, Pohang: Lecturer/Instructor for Research and Education Programs

Mar. 2005-Jun. 2005, POSTECH: Teaching Assistant for Computational Physics\*\*

Sep.-Dec. 2003, POSTECH: Teaching Assistant for Modern Physics\*\*

Mar.-Jun. 2003, POSTECH: Teaching Assistant for Modern Physics\*\*

## Grants

2022-2025, Principal Investigator, Institute for Basic Science Young Scientist Fellowship, Information Flow and State Transitions in Human Cerebral Cortex

2020-, Key Personnel, NIH R01, Integrating and Separating Information Sequences in the human cerebral cortex (Principal Investigator: Christopher Honey)

2017-2021, Key Personnel, NIH R01, Defining Neuronal Circuits and Cellular Processes Underlying Resting fMRI Signals (Principal Investigator: Charles Schroeder and Michael Milham)

2016-2017, Key Personnel, NIH R01, A Computational, Neurobiological and Clinical Study of Cortical Connectivity during Consciousness & Anesthesia (Principal Investigator: George Mashour and UnCheol Lee)

## Mentorship

**Jaehyung Woo**, 2019-2020, Johns Hopkins University:

Phase and Amplitude Dynamics of Coupled Oscillator Systems on Complex Networks. *Chaos* 30(12): 121102 (2020).

**Joseph Lee**, 2016-2017, University of Michigan:

How Global Network Topology Generates Directionality in Dynamics of Brain Networks across Different Species. *Scientific Reports* 7: 46606 (2017).

**Minkyung Kim**, 2016-2017, University of Michigan:

How Global Network Topology Generates Directionality in Dynamics of Brain Networks across Different Species. *Scientific Reports* 7: 46606 (2017).

**Jun-Hyeok Kim**, 2015-2019, Pohang University of Science and Technology:

Various Synchronous States Due to Coupling Strength Inhomogeneity and Coupling Functions in Systems of Coupled Identical Oscillators. *Chaos* 29(1): 011106 (2019).

How Global Network Topology Generates Directionality in Dynamics of Brain Networks across Different Species. *Scientific Reports* 7: 46606 (2017).

Phase Lead/Lag Due to Degree Inhomogeneity in Complex Oscillator Network with Application to Brain Networks. *BMC Neuroscience* 16 (Suppl 1): 127 (2015).

## Papers

### *Papers in Preparation*

Jaehyung Woo, Christopher Honey, and **Joon-Young Moon**. Hysteresis in Coupled Oscillator Systems with Phase and Amplitude Dynamics. *In Preparation*

**Joon-Young Moon**, Charles Schroeder, and Christopher Honey. Identifying Large-Scale States of Internal and External Mode in the Human Cerebral Cortex and Transitions between the Modes. *In Preparation*

**Joon-Young Moon**, and Eric LaRock. Concept of Emergence from the Perspective of Physical Science. *In preparation for submission to British Journal of Philosophy of Science*  
<https://arxiv.org/pdf/1705.11075.pdf>

**Joon-Young Moon**, Kathrin Müsch, Charles Schroeder, and Christopher Honey. Inter-Regional Delay in the Human Cerebral Cortex Fluctuates and Is Correlated with Low-Frequency Power of Brain Waves.

*Published Papers* (+contributed as the corresponding author, \*contributed equally as the co-first authors)

**Joon-Young Moon**, Kathrin Müsch, Charles Schroeder, and Christopher Honey, Fluctuating Inter-Regional Delays in the Human Cerebral Cortex. *Journal of Computational Neuroscience* 49 (Suppl 1), S24-S26 (2021).

Jaehyung Woo, Christopher Honey, and **Joon-Young Moon**<sup>+</sup>. Phase and Amplitude Dynamics of Coupled Oscillator Systems on Complex Networks. *Chaos* 30(12): 121102 (2020).

Jun-Hyeok Kim\*, **Joon-Young Moon**\*, UnCheol Lee, and Tae-Wook Ko. Various Synchronous States Due to Coupling Strength Inhomogeneity and Coupling Functions in Systems of Coupled Identical Oscillators. *Chaos* 29(1): 011106 (2019).

Hyoungkyu Kim\*, **Joon-Young Moon**\*, George Mashour, and UnCheol Lee. Mechanisms of hysteresis in human brain networks during transitions of consciousness and unconsciousness: Theoretical principles and empirical evidence. *PLoS Computational Biology* 14(8): e1006424 (2018).

**Joon-Young Moon**, Jun-Hyeok Kim, Tae-Wook Ko, Minkyung Kim, Yasser Iturria Medina, Jee-Hyun Choi, Joseph Lee, George Mashour, and UnCheol Lee. Structure Shapes Dynamics and Directionality in Diverse Brain Networks: Mathematical Principles and Empirical Confirmation in Three Species. *Scientific Reports* 7: 46606 (2017).

**Joon-Young Moon**, Uncheol Lee, Stefanie Blaine-Moraes, and George Mashour. General Relationship of Global Topology, Local Dynamics, and Directionality in Large-Scale Brain Networks. *PLoS Computational Biology* 11(4): e1004225 (2015).

Jun-Hyeok Kim, **Joon-Young Moon**, UnCheol Lee, George Mashour, Seunghwan Kim, Tae-Wook Ko. Phase Lead/Lag Due to Degree Inhomogeneity in Complex Oscillator Network with Application to Brain Networks. *BMC Neuroscience* 16 (Suppl 1): 127 (2015).

Ho-Yong Kim, **Joon-Young Moon**, Gab-Jin Oh. Study on Statistical Properties in Korean Stock Market. *International Industrial Information Systems Conference 2014*, 95-96 (2014).

Kye-Yeon Hur, **Joon-Young Moon**, Seung-Hwan Kim, and Joo-Yeon Yoo. Model-Based Simulation and Prediction of an Antiviral Strategy against Influenza A Infection. *PLoS ONE* 8(7): e68235 (2013).

**Joon-Young Moon**, Dongmyeong Lee, Jack H. Koolen, and Seunghwan Kim. Core-Periphery Disparity in Fractal Behavior of Complex Networks. *Physics Review E* 84, 037103 (2011).

## Conference/Seminar Talks

Jul. 5, 2022, Seminar at National Institutes of Health (NIH), Online. Information Flow and State Transitions in Human Cerebral Cortex.

Jul. 1, 2022, Seminar at University of Michigan, Online. Information Flow and State Transitions in Brain.

Jun. 27, 2022, Seminar at Nathan Kline Institute, Online. Information Flow and State Transitions in Brain.

Jun. 16, 2022, Seminar at Drexel University, Online. Information Flow and State Transitions in Human Cerebral Cortex.

May 16, 2022, Seminar at Allen Institute, Online. Information Flow and State Transitions in Brain.

Apr. 24, 2022, Seminar at University of Southern Mississippi University, Hattiesburg, Mississippi. Information Flow and State Transitions in Brain.

Jul. 5, 2021, 30th Annual Computational Neuroscience Meeting, Online. Fluctuating Inter-Regional Delays in the Human Cerebral Cortex.

Oct. 23, 2019, Society for Neuroscience Annual Meeting (SfN) 2019, Chicago, Illinois. Fluctuating Inter-Regional Delays in the Auditory Hierarchy of the Human Cortex.

Oct. 25, 2018, Seminar at University of Pennsylvania, Philadelphia, Pennsylvania. Mechanisms of Hysteresis in Human Brain Networks during Transitions of Consciousness and Unconsciousness.

Aug. 3, 2018, Seminar at Seoul National University, Relationship of Global Topology and Directionality in Brain Networks.

Aug. 2, 2018, Seminar at Sungkyunkwan University, Relationship of Global Topology and Directionality in Brain Networks.

Jul. 30, 2018, Seminar at Korean Institute of Science and Technology, Relationship of Global Topology and Directionality in Brain Networks.

Jul. 27, 2018, Seminar at Pohang University of Science and Technology, Relationship of Global Topology and Directionality in Brain Networks.

Jul. 21, 2017, Seminar at Johns Hopkins University, Baltimore, Maryland. Relationship of Global Topology and Directionality in Large-Scale Brain Networks.

Nov. 15, 2016, Society for Neuroscience Annual Meeting (SfN) 2016, San Diego, California. How Network Topology Shapes Directionality of Information Flow in Brain Networks across Different Species.

Apr. 27, 2016, Toward a Science of Consciousness 2016, Tucson, Arizona. Network Topology and Directional Connectivity Patterns in Mouse, Monkey and Humans: Implications for the Evolution of Consciousness.

Sep. 28, 2015, 25th Conference on Complex Systems, Tempe, Arizona. General Relationship of Global Topology, Local Dynamics, and Directionality in complex Networks and Brain Networks across Different Species.

Aug. 5, 2013, Seminar at Sungkyunkwan University, Suwon, Korea. Information Flow of the Brain and Anesthesia.

Aug. 1, 2013, Seminar at Pohang University of Science and Technology, Pohang, Korea. Simple Oscillator Models and the Information Flow of the Brain.

Jul. 30, 2013, Seminar at National Institute for Mathematical Sciences, Deajeon, Korea. Reproducing Information Flow of Brain Networks with Simple Models.

Jan. 13, 2012, Seminar at Korean Institute of Science and Technology, Seoul, Korea. Fractal Dimension of EEG.

Oct. 20, 2011, Korea Physics Society Fall Meeting 2011, Busan, Korea. Another Method to Measure Fractal Dimension of Complex Networks.

Aug. 19, 2011, 16th Workshop for Statistical Physics, Busan, Korea. Ising Model on a Multifractal Network.

Sep. 16, 2011, 21st European Conference on Complex Systems, Vienna, Austria. A multifractal Hierarchical Scale-Free Network and Ising Model on the Network.

June 27, 2011, 8th International Conference on Complex Systems, Quincy, MA. USA, Core-Periphery Disparity in Fractal Behavior of Complex Networks.

Aug. 14, 2009, 16th Workshop for Statistical Physics, Gwangju, Gyeonggi, Korea. Comparison of Various Fractal Measurement Methods Applied on Fractal Lattices.

## **Conference/Seminar Posters** (\*\*best poster award)

Nov. 9, 2021, Society for Neuroscience Annual Meeting (SfN) 2021, Online. Fluctuation of Inter-Regional Delays in the Human Cerebral Cortico-Cortical Communication.

Jun. 1, 2020, Brain Initiative Investigators Meeting 2020, Online. Fluctuating Inter-Regional Delays in the Human Cerebral Cortex.

Sep. 14, 2019, Cognitive and Computational Neuroscience (CCN) 2019, Berlin, Germany. Synchronized and Propagating States of Human Auditory Processing.

Apr. 13, 2019, Brain Initiative Investigators Meeting 2019, Washington, DC. Fluctuating Inter-Regional Delays in the Auditory Hierarchy of the Human Neocortex.

Jun. 21, 2017, International Conference on Network Science (NetSci) 2017, Indianapolis, Indiana. General Relationship between Network Topology and Directionality of Information Flow: with Application to Brain Networks across Different Species.

Apr. 25, 2014, Toward a Science of Consciousness 2014, Tucson, Arizona. Consciousness and Information Flow in Complex Brain Networks.

Sep. 3, 2012, European Conference on Complex Systems 2012, Brussels, Belgium. Minimum-Spanning-Tree Dimension of Electroencephalogram.

Nov. 26, 2011, Dasan Conference 2011 "Cosmic Brain Network", Yeosu, Korea. MST Dimension of EEG.

April 14, 2011, Korea Physics Society Spring Meeting 2011, Daejeon, Korea. A Multifractal Hierarchical Scale-Free Network and Ising Model on the Network.

Jan. 21, 2011, 4th Young Physicists Workshop, Pohang, Korea. Ising Model on a New Class of Scale-Free Fractal Networks.\*\*

Oct. 21, 2010, Korea Physics Society Fall Meeting 2010, Peyongchang, Korea. Ising Model on the Fractal Hierarchical Scale-Free Lattices.\*\*

Oct. 21, 2010, Korea Physics Society Fall Meeting 2010, Peyongchang, Korea. Core-Periphery Disparity in Fractal Behavior of Complex Networks.

April 18, 2008, Korea Physics Society Spring Meeting 2008, Daejeon, Korea. Measuring the Fractal Dimension of Complex Networks.

Aug. 23, 2007, the 10th Asia Pacific Physics Conference (APPC 10), Pohang, Korea. 'MST Dimension' of Complex Networks.

## **Membership**

Organization for Computational Neuroscience  
Society for Neuroscience  
American Physical Society

## **Reviewer Activities**

Cerebral Cortex

Chaos, Solitons & Fractals  
NeuroImage  
Frontiers in Human Neuroscience  
Communications Biology

## Other Services

2016, President of Korean Biological Research Group in Michigan

2013-2017, Member of Korean Biological Research Group in Michigan

2010-11, Co-Head of Preparation Committee for Young Physicist Workshop of SNU, KAIST, and POSTECH

2009, President of Physics Graduate Student Association, POSTECH

2001, President of Physics Undergraduate Student Association, POSTECH

## Contacts for References

**Christopher J. Honey**, Assistant Professor, Department of Psychological and Brain Sciences, Johns Hopkins University, Baltimore, MD

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**UnCheol Lee**, Assistant Professor, Center for Consciousness Science, Department of Anesthesiology, University of Michigan Medical School, Ann Arbor, MI

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**Eric LaRock**, Associate Professor, Department of Philosophy, Oakland University, Rochester, MI

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**Seunghwan Kim**, Professor, Department of Physics, POSTECH, Pohang, Gyeongbuk, Republic of Korea

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**John D. Murray\***, Assistant Professor, Department of Psychiatry, Yale School of Medicine, New Haven, CT

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\* for the letter of reference containing teaching evaluation