



**PREPARE FOR
AN ADVENTURE**

Why are we here?



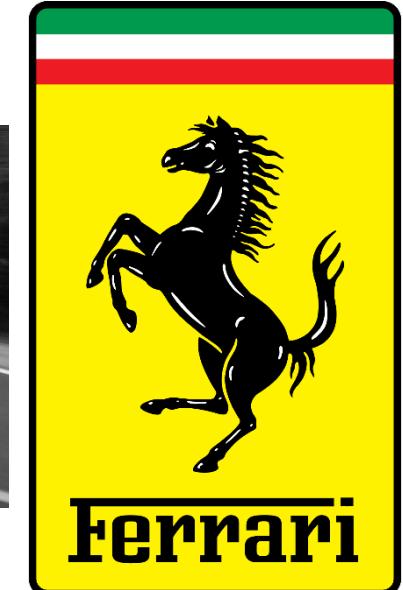
A graphic representation of Italy's regions and cities, where the word "Italy" is formed by the names of various Italian locations. The letters are composed of city names in red, green, and white, corresponding to the colors of the Italian flag.

The regions and cities forming the letters are:

- I**: Udine, Pescara, Palermo, Soave, Bergamo, Arezzo, Massa, Lecco, Brescia, Strascusa, Rieti, Ferreria, Lerici, Gubbio, Vicenza, Gaeta, Novara, Merano, Barletta, Brunico, Chioggia.
- t**: Venezia, Trieste, Campobasso, Bologna, Pesaro, Biella, Matera, Tarquinia, Spoleto, Feltigno, Grosseto, Savona, Altopiano di Asiago, Asolo, Viterbo, Melfi, Reggio Emilia, Asti, Cosenza, Istria.
- a**: Genova, Genova, Aquila, Trento, Verona, Verona, Mantova, Empoli, Sassari, Faenza, Bari, Enna, Ognina, Ispica.
- Y**: Gorizia, Belluno, ASSISI, Perugia, Tivoli, Cagliari, Latina, Pisa, Firenze, Potenza, Alessandria, Cuneo, Nuoro, Cuneo, Cuneo, Cuneo, Como, Lucca, Lecco.



Land of...





Como



Villa Del Grumello

A scenic view of a lakefront town, likely Bellagio on Lake Como, Italy. The town is built on a hillside overlooking a deep blue lake. In the foreground, there's a stone wall with flower boxes and a wooden railing. The town features numerous buildings with red-tiled roofs, pastel-colored facades, and a prominent church tower. A pier extends into the water from the town's edge. The background shows more hills covered in greenery under a bright blue sky with some white clouds.

**Of course for...
the beauty**



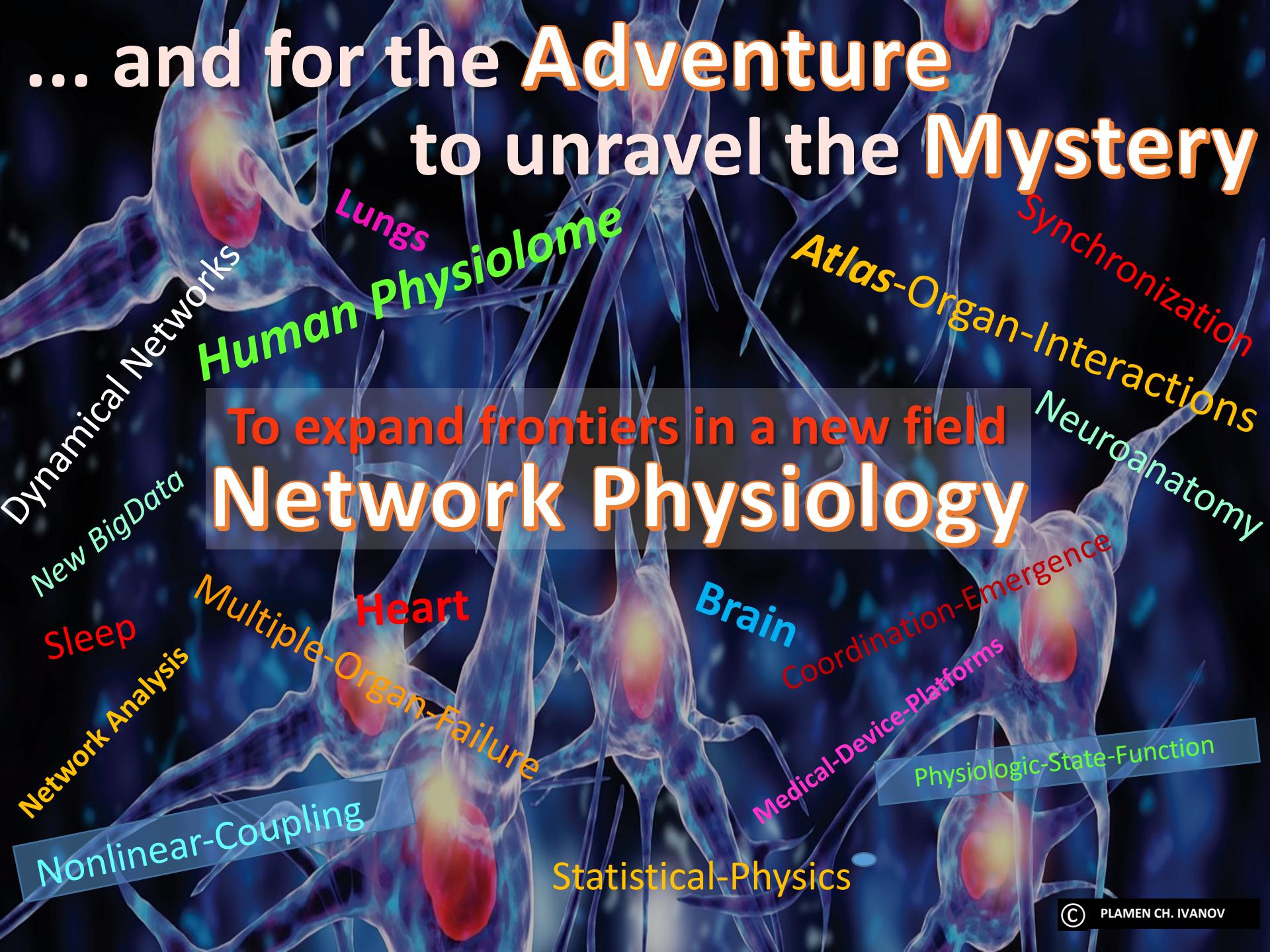
Culture

The experience



... and for the Adventure
to unravel the Mystery

To expand frontiers in a new field
Network Physiology

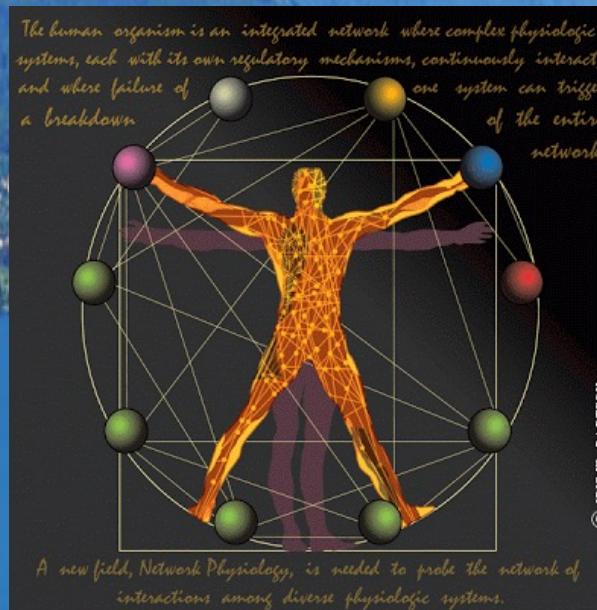


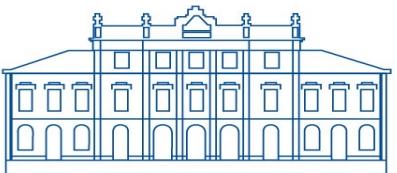


Third International Summer Institute on Network Physiology (ISINP)

Lake Como School of Advanced Studies, 24 – 29 July 2022

WELCOME!





Fondazione
Alessandro Volta

fondazionealessandrovolta.it



Alessandro Volta
(1745-1827)



WE THANK

**Fondazione
Alessandro Volta**



**Third International Summer Institute
on Network Physiology (ISINP)**

Lake Como School of Advanced Studies, 24 - 29 July 2022



Battery
Inventor

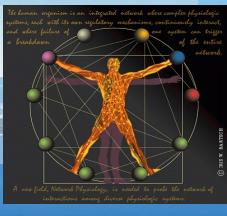
$$V = I \cdot R$$





Third International Summer Institute on Network Physiology (ISINP)

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WE THANK



This international institute builds on groundbreaking research in Network Physiology that has been made possible by support from the **W. M. Keck Foundation.**



Frontiers in Network Physiology

Frontiers in Network Physiology is the first journal publishing rigorously peer-reviewed research dedicated to furthering our understanding of network physiology. This multidisciplinary, open-access journal is at the forefront of communicating impactful scientific discoveries to academics and clinicians.



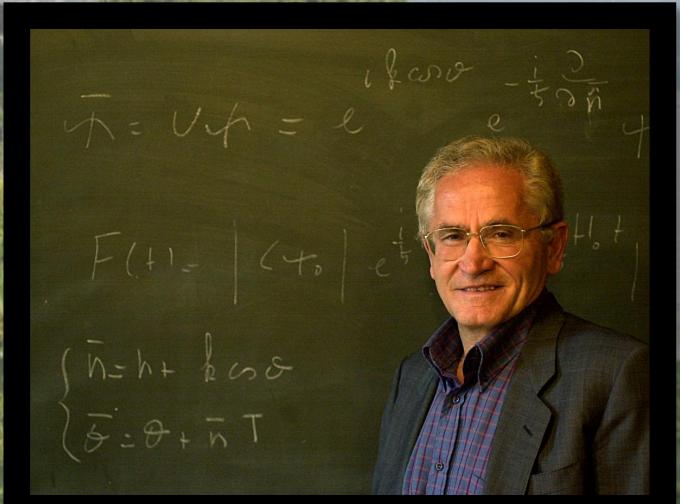


LAKE COMO SCHOOL
OF ADVANCED STUDIES

WE THANK



Special thanks to
Prof. Giulio Casati
Scientific Director



Some Pre-history: New Field of Network Physiology



First Work:

Nature Communications vol. 3:702 (2012)

“Network Physiology reveals relations between network topology and physiological function”



Generated Broad Interests in the Community

1st Symposium on Network Physiology and Medicine, Oct. 2012



THE HARVARD CLINICAL AND TRANSLATIONAL SCIENCE CENTER

Science News Cover Story, 2012

The Science News cover story features a large image of a human body with glowing blue nodes and lines representing a network. The title is "When Networks Network". The text discusses how systems like the heart and lungs interact in complex ways.

When Networks Network

Once studied solo, systems display surprising behavior when they interact

By Elizabeth Quill

Half a dozen times each night, your sleeping body performs a remarkable feat of coordination. During the deepest stages of sleep, the body's organs self-tune their own timetables. Nerve cells along in your brain, their rhythmic general oscillations synchronize across stages. Yet, like waves and trains with overlapping routes but unpredictable arrival times, different systems have little to say to your heart, which pumps blood to its own rhythm through the body's arteries and veins. These sleep rhythms, too, rise and fall and down the whistling in seemingly random splits and spurs. And music fluctuations that make you want to dance can create a vacuum. Networks of muscles, fibrin cells, of arteries and lungs, of heart and veins, all self-tune their activity every couple of hours, though, as little as 30 seconds, the human heart does not stop beating. At the deepest activity of deep sleep starts to connect with its surroundings. Just how these systems self-tune, and what it takes to do so, has been a mystery off the molecular, cellular and nervous players – join the team.

This shared, rhythmic precision from deep sleep may very recently been understood in detail – thanks to a new look at when and how the body's myriad networks link up to form an interconnected system.

Hunting ExoEarths: Distant DNA is Full | Secrets of Seism

Linking Up
Perils and promises of connecting networks

Star Factory
Skinning Turtles
Cats-Solving Crimes

In balance. But the not an narrow nor butterflies. Much of the recent focus has been on the potential dangers that

Several reports – such as the CNS coverage – have highlighted areas where how fragile interdependent systems

September 22, 2012 | SCIENCE NEWS | 19

Special Issue, 2014

The cover of the "New Journal of Physics" special issue on Network Physiology and Network Medicine. It features a diagram of a human figure with nodes and lines representing a network, and the text: "A new field, Network Physiology, is needed to probe the network of interactions among diverse physiological systems".

IOPscience Journals Books Login

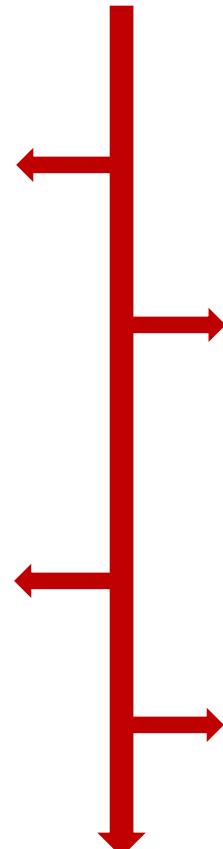
New Journal of Physics
The open access journal at the forefront of physics

Focus on Network Physiology and Network Medicine

Plamen Ch Ivanov, Boston University and Harvard Medical School, USA

The scope of the issue encompasses both network physiology and network medicine, where new concepts and approaches derived from recent advances in the theory of Complex Networks are applied to provide insights into physiological structure and function in health and disease, from the genetic and sub-cellular level to inter-cellular interactions and communications across integrated organ systems. Of particular interest will be new and little-explored areas of network science including the following.

- Studies on structural and dynamical aspects of physiological systems that transcend time and space scales.
- Networks comprised of diverse dynamical systems.
- The role of time-dependent network interactions for emergent transitions in network topology and function.
- Structure-function dependence.
- Manipulation, control and global dynamics of networks



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Physiological Measurement

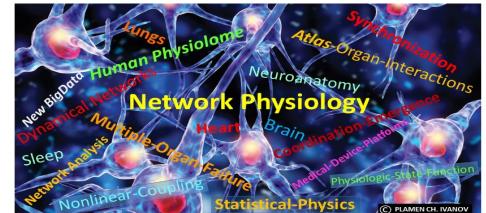
Special Issue, 2016

The new field of Network Physiology: redefining health and disease through networks of physiological interactions

Plamen Ch. Ivanov Boston University and Harvard Medical School, USA

Scope

The human organism is an integrated network, where physiological systems and organs, each with its own regulatory mechanism, continuously interact to coordinate their functions. Physiological interactions are essential to produce distinct physiologic states,

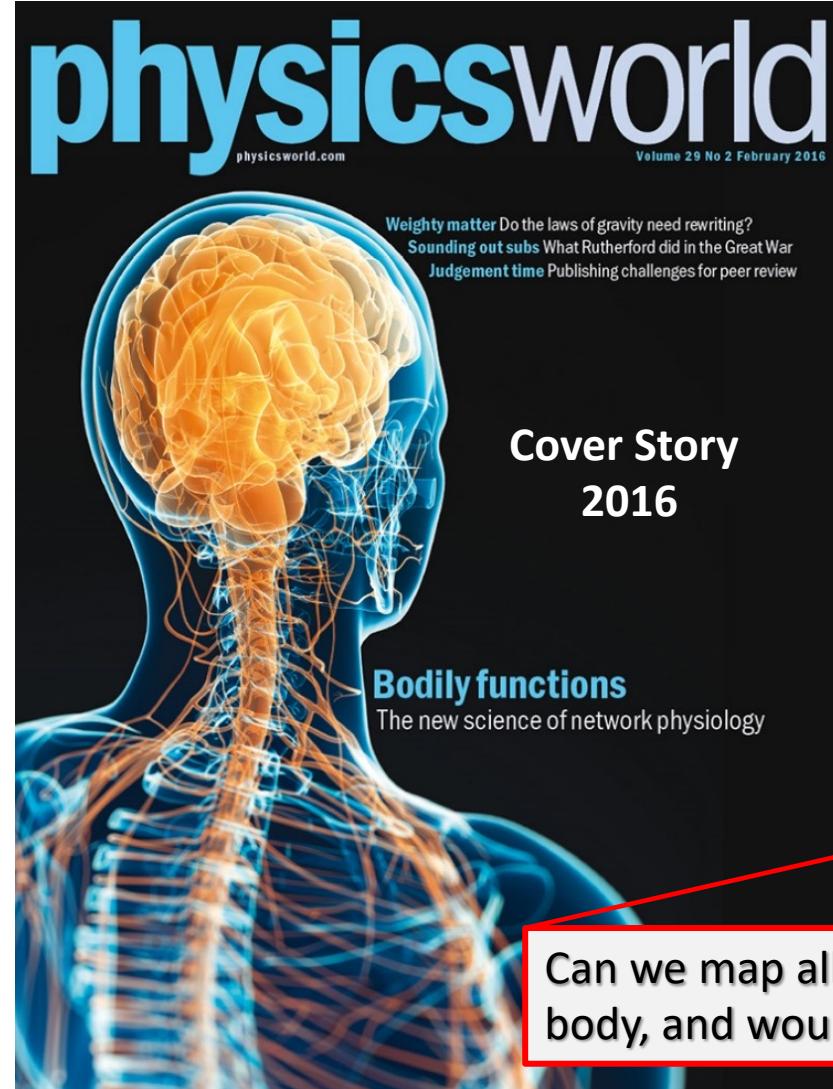


Network Physiology

IOP Institute of Physics



Medicine/Clinical Practice



Revealing the network within

Can we map all the information being circulated in the human body, and would doing so be any use? **Jon Cartwright** explores the emerging interdisciplinary field of "network physiology"

It might seem obvious to say that everything in the human body is connected. Without a doubt, your various organs – heart, liver, lungs – work together to keep you alive, and functioning as close to normally

ity. Studying these fluctuations, he says, could give us an entirely new window into the workings of the human body – and help us prevent things going wrong.

Ivanov has grand ambitions. He wants to draw on

Jon Cartwright is a freelance journalist based in Bristol, UK, <http://jcartwright.com>.

Can we map all the information being circulated in the human body, and would doing so be any use?

least the beginnings of an answer. Having developed sciences until now," he says.

Large-Scale Interdisciplinary Effort



USA

Mexico

UK

Spain

France

Germany

Italy

Switzerland

First Inaugural Scientific Meeting

ISINP 2017

69 participants from 16 countries



Bulgaria

Slovakia

India

China

Japan

Hungary

Israel

Romania



Large-Scale Interdisciplinary Effort



A dense network of blue and purple neurons against a dark background.

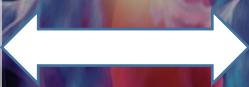
why a new field?

What is a field?

- A group of closely-related fundamental questions
- Distinctive approach
- Specific analytic formalism and theoretical framework
- Broad relevance to many systems and states

In the discipline of Physics

Classical
Mechanics



Quantum
Mechanics



Statistical
Mechanics

The new field of Network Physiology

Fundamental Questions:

- Nature of communication between physiological systems and sub-systems?
- How systems dynamically coordinate and synchronize their functions?
- Emergence of states and conditions at the organism level out of physiologic network interactions?
- Basic principles of integration and network control mechanisms of the “body internet”?

The new field of Network Physiology

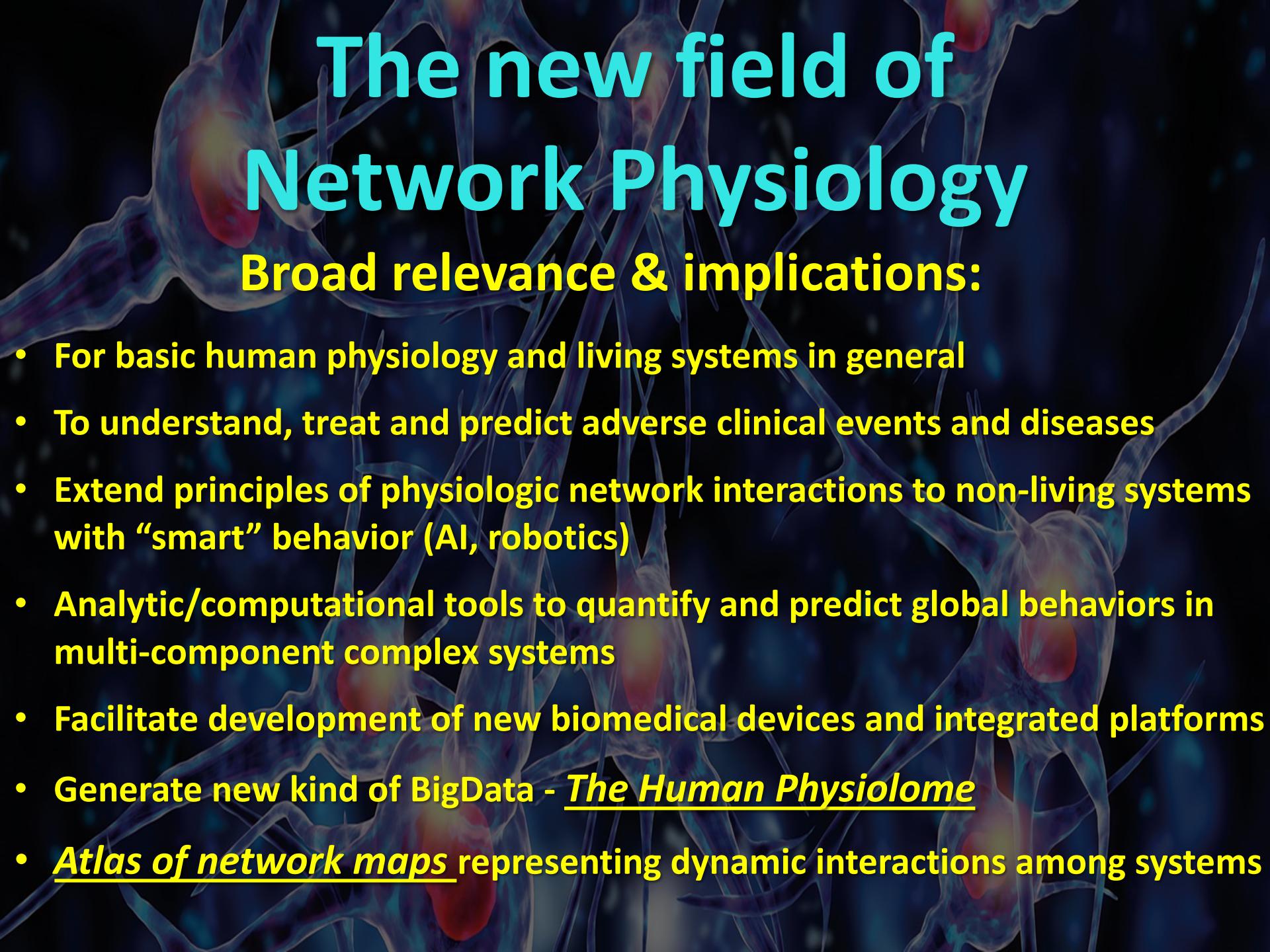
Distinctive approach:

- Depart from phenomenalological observation of organ interactions
- Quantitative physical description of physiologic coupling
- Shift focus from single organ system to entire physiologic network
- Identify relation between physiologic states, behaviors and functions & networks of organ interactions
- BigData of high-frequency synchronized continuous recordings

The new field of Network Physiology

Requires new analytic formalism
& theoretical framework:

- To identify and quantify coupling from noisy, non-linear and transient physiologic signals
- To describe emergent global behaviors in networks of diverse dynamical systems
- Establish principles of control in networks of dynamical systems
- Define a “*set of equations*” that describes physiologic state and function at the organism level



The new field of Network Physiology

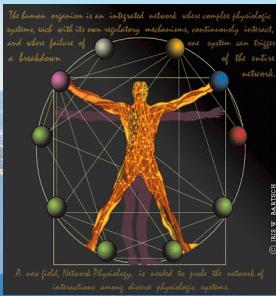
Broad relevance & implications:

- For basic human physiology and living systems in general
- To understand, treat and predict adverse clinical events and diseases
- Extend principles of physiologic network interactions to non-living systems with “smart” behavior (AI, robotics)
- Analytic/computational tools to quantify and predict global behaviors in multi-component complex systems
- Facilitate development of new biomedical devices and integrated platforms
- Generate new kind of BigData - *The Human Physiolome*
- *Atlas of network maps* representing dynamic interactions among systems



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Brain Neuronal Networks

Cardio-Respiratory Network

Brain-Kidney Network

Auditory Networks

Organ Networks

Muscle Networks

Dental Networks

Kidney Networks

Lung Tissue Networks

Brain-Muscle Networks

Mitochondrial Networks

Myocardial Cells Networks

Pancreas and β Cells Networks

Co-morbidity Networks

Metabolic Networks

Systems

Mathematical & Computational
Methods

Multiple Organ Failure

Sleep and Sleep Disorders

Brain Trauma

Epilepsy

Fibromyalgia

Diabetes

COVID-19

Sepsis

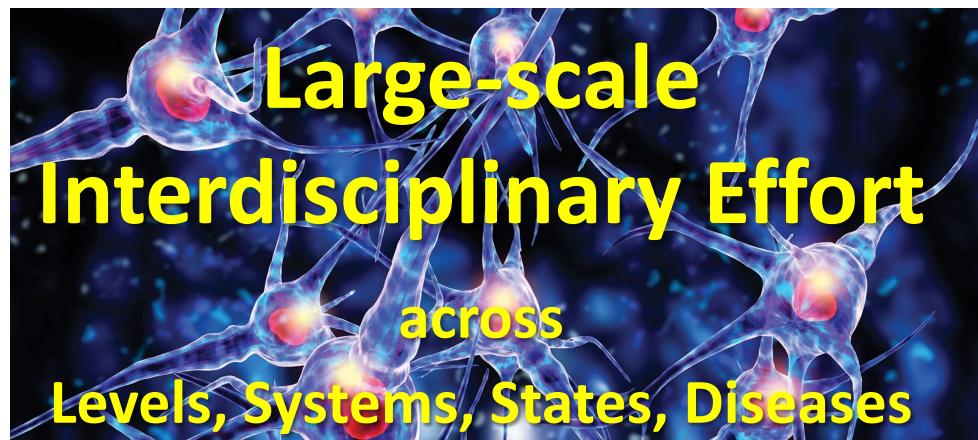
Aging

Migraine

Cancer Networks

Chronic Pain Syndrome

Acute Respiratory syndrome

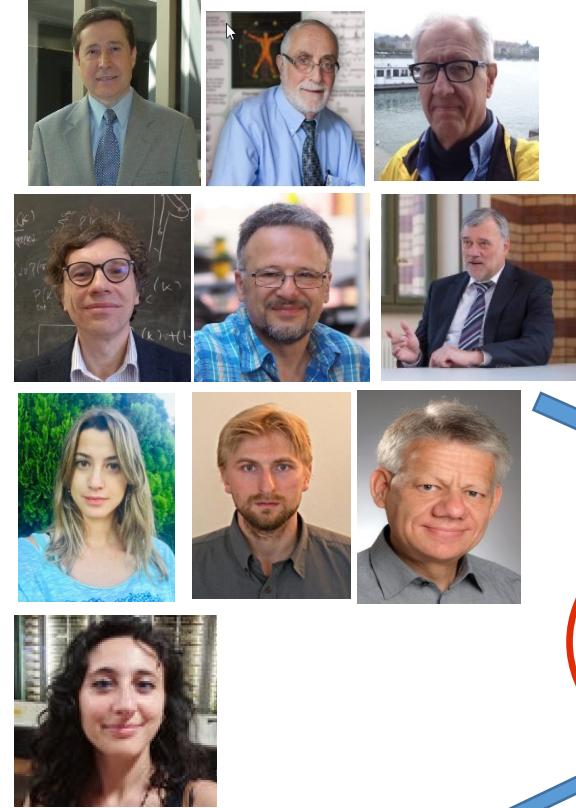


Biomedical Engineering
Devices & Platforms

Conditions

Large-Scale Interdisciplinary Effort

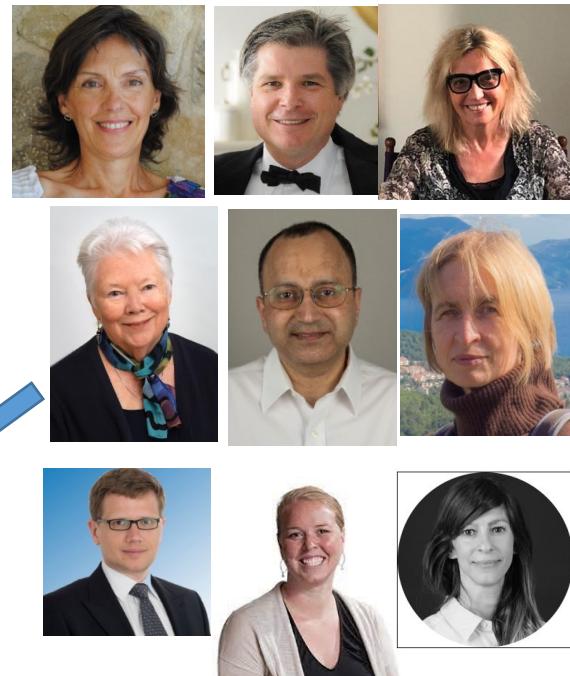
Physics & Applied Math



Neuroscience



Physiology/Medicine



Network
Physiology

Biomedical Engineering



Computational & Data Science



Large-Scale Interdisciplinary Effort

The image features a vibrant blue and purple neural network background at the top. Below it is a grid of country flags and names. In the center is a map of northern Italy showing major cities like Milan, Bergamo, and Lake Maggiore, with a red dot marking 'Villa Del Grumello'. At the bottom is a scenic photograph of a lake surrounded by mountains.

Country	Flag
USA	
UK	
Canada	
Germany	
Italy	
Spain	
Portugal	
Denmark	
Bulgaria	
Slovenia	
Serbia	
Poland	
Israel	
Mexico	
Switzerland	

**Third International Summer Institute on Network Physiology
ISINP 2022**

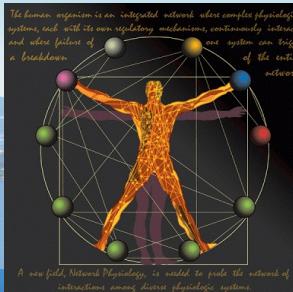
70 participants from 15 countries

Villa Del Grumello



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Announcements Program

Poster Sessions

- Poster Session I 17:00-18:30h, Monday, 25 July, 2022
- Poster Session II 17:00-18:30h, Tuesday, 26 July, 2022

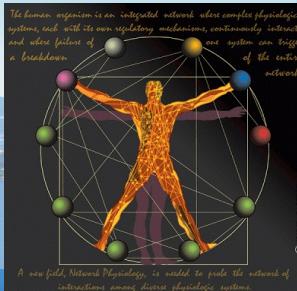
Round Table Discussion

- Round Table 17:00-18:30h, Wednesday, 27 July, 2022



Third International Summer Institute on Network Physiology (ISINP)

Lake Como School of Advanced Studies, 24 - 29 July 2022



Announcements

Poster Awards

First Prize
Second Prize
Third Prize



Frontiers in Network Physiology

Frontiers in Network Physiology is the first journal publishing rigorously peer-reviewed research dedicated to furthering our understanding of network physiology. This multidisciplinary, open-access journal is at the forefront of communicating impactful scientific discoveries to academics and clinicians.

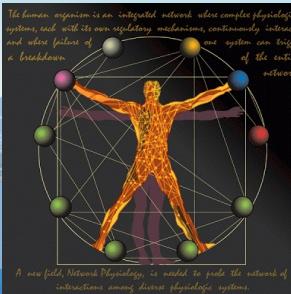


Frontiers is the 3rd most-cited and 9th largest research publisher and we publish groundbreaking discoveries by the world's top experts. We place the researcher at the center of everything we do and enable the research community to develop the solutions we need to live healthy lives on a healthy planet.



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**Focus issues on network physiology
now open in the journal**



Frontiers in Network Physiology

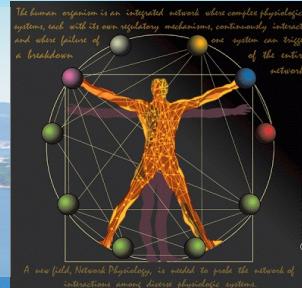


- “*Kidney Structure and Function: Interdisciplinary Approaches in Basic and Translational Research*”
- “*Network Physiology Approaches to Natural and Data-Driven Multi-Omics and High-Frequency Networks: Methodologies and Applications to Clinical Medicine*”
- “*Astrocytes in the Brain Active Milieu*”
- “*Brain-Heart Interaction: Recent Insights in Methods Cortico-muscular network interactions*”



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Announcements

Social event

Dinner

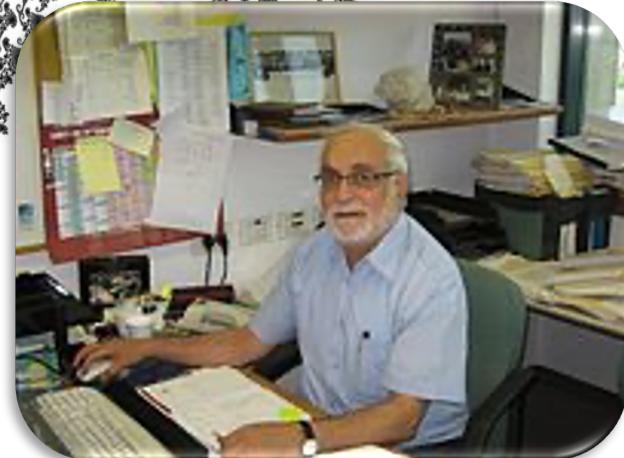
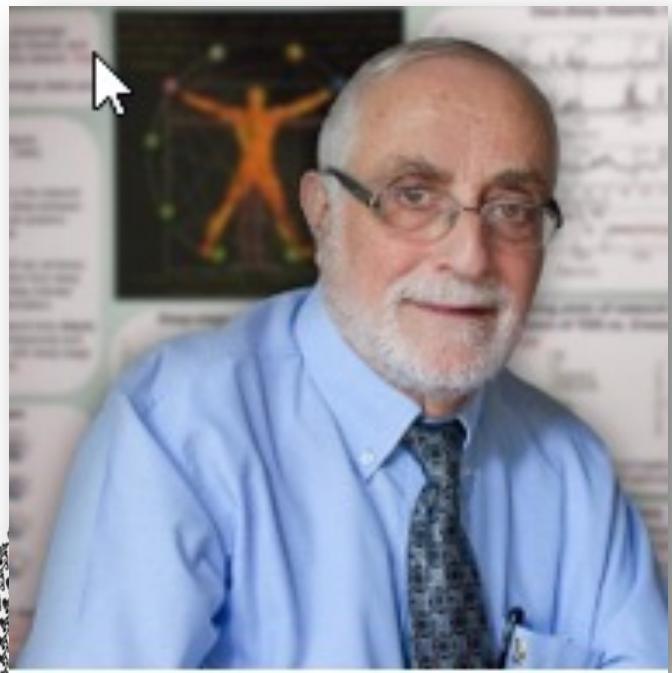
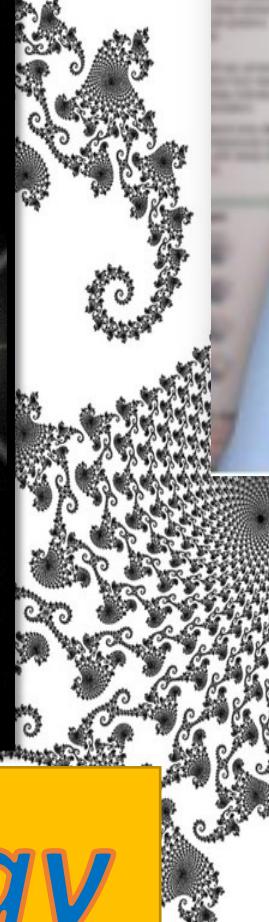


Ristorante Sociale

Thursday, 28 July, 2022

20:30h





*Happy Birthday
Shlomo!*