Big Data Research

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Statistical genetics and biostatistics

Dr. Amei Amei

Professor,

Department of Mathematical Sciences

Email: amei.amei@unlv.edu

Expertise

- Statistical methods to detect risk genes and gene-environment interactions underlying complex diseases
- Large-scale sequence-based genetic association studies
- Statistical inference of stochastic modeling
- Bayesian variable selection

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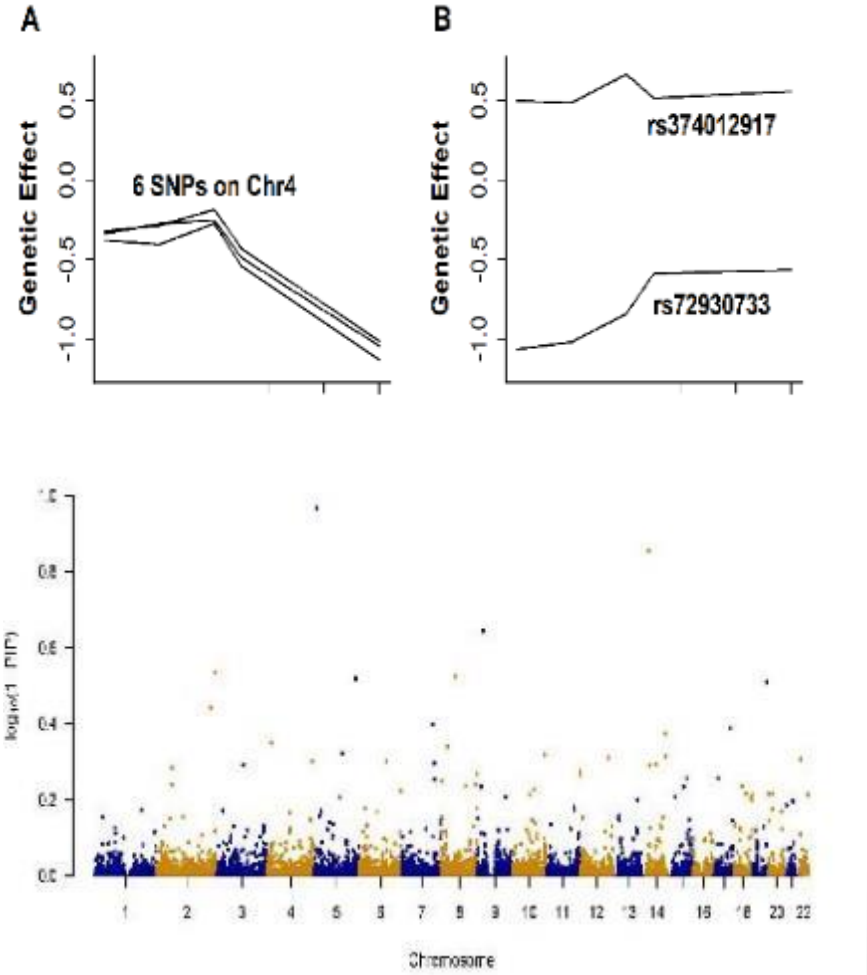
Genome-wide association studies in hypertension and schizophrenia

- In genome-wide association analysis of longitudinal traits, modeling time-varying genetic effect can increase power for the detection of genes underlying the development and progression of complex diseases.
- BVS methods can be used to reanalyze published datasets to discover new risk genetic variants for many diseases without new sample collection, ascertainment, and genotyping.



Critical Zone Hydrology

- **Dr. Hannes Bauser**
- Assistant Professor
- Department of Geoscience
- Email: hannes.bauser@unlv.edu
- Website: https://geoscience.unlv.edu/people/department-faculty/hannes-bauser/

Expertise

- Vadose Zone Hydrology and Soil Physics
- Hydrologic Modeling
- Data Assimilation
- Machine Learning

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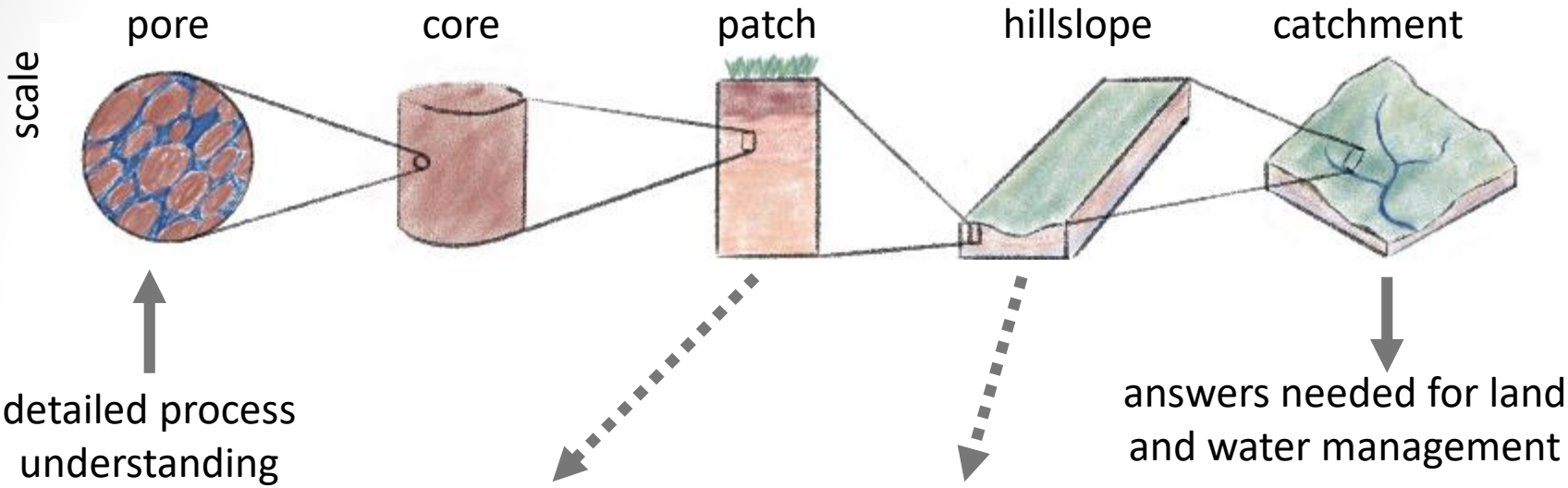
Hydrologic Scaling Challenge



Collaboration with the Desert Research Institute for access to the SEPHAS Lysimeters in Boulder City.

Collaboration with the University of Arizona for access to the Landscape Evolution Observatory at Biosphere 2.

How can we use data science (e.g., data assimilation, machine learning) to combine process understanding and data to solve the hydrologic scaling challenge?

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Combinatorial algebraic geometry

- **Dr. Daniel Corey**
- Assistant Professor
- Department of Mathematical Sciences
- Email: daniel.corey@unlv.edu
- Website: https://www.danieljcorey.com/

Expertise

- Tropical geometry
- Grassmannians and flag varieties
- Matroids, graphs, and polyhedral complexes
- Software: OSCAR (julia), polymake, Macaulay2

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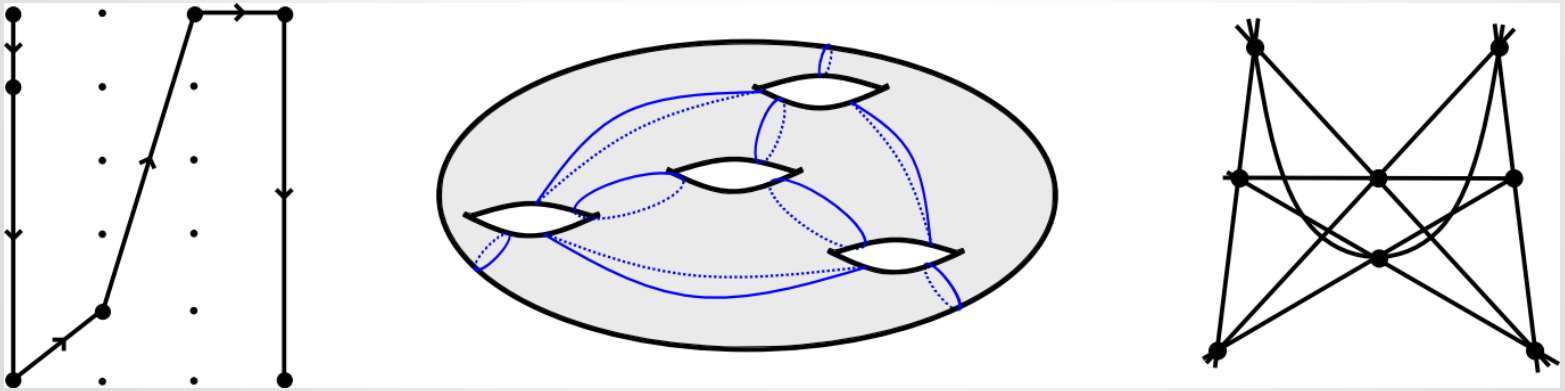
Tropical geometry: combinatorics of degenerating algebraic varieties

Tropical geometry is a relatively new field that lies at the intersection of various seemingly distant areas of mathematics and computer science, like auction and game theory, optimization, machine learning, graphs, matroids, polyhedral complexes, and algebraic geometry. Within algebraic geometry, tropical geometry is the study of degenerating algebraic varieties. The degenerated object should have a purely combinatorial description, and as a result one may transform a geometric problem into a combinatorial one. Below are examples of combinatorial objects that arise in my research. Left to right, these are: a lattice path (used to enumerate curves in toric surfaces), vanishing cycles of a stable degeneration of Riemann surfaces (used to study the Ceresa cycle of a curve) and a matroid (used to study compactifications of the moduli space of lines in the projective plane in general position).



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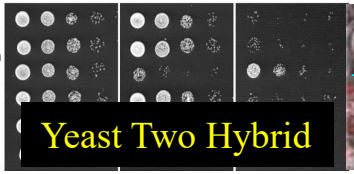
Dr. Jeffery Shen
Professor,
School of Life Sciences
Phone: 702-895-4704
Email: jeffery.shen@unlv.edu

Expertise

- Big Data Analysis to Study Biology, Agriculture and Medicine
- Molecular Mechanisms Controlling Plant Responses to Drought Heat, and Salinity
- Seed Germination, Tissue Culture and Plant Transformation
- Molecular Basis of Leukemia (in collaboration with Dr. J. Cheng at the University of Chicago Medical School)
- Nutrition of Cereal Crops (in collaboration with Dr. Christine Bergman, Ph.D. and R.D. at UNLV)

Molecular Basis of Drought Stress Responses and Seed Germination



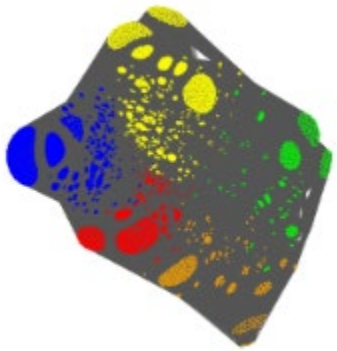
BMC Genomics, 2016, 17:102
Plant Science, 2015, 236:214-222
Front. Plant Science,2015; 6: 1145
Trends in Plant Sci, 2010, 15: 247

Short Read Assembly Algorithm

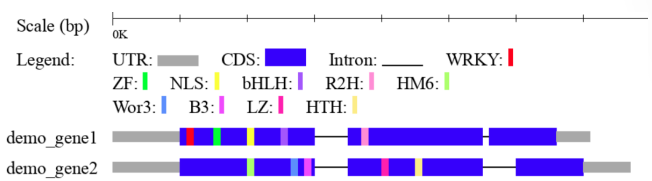
for Genome and Transcriptome Analysis

http://shenlab.sols.unlv.edu/shenlab/software/Tiling_Assembly/tiling_assembly.html

DNA Research, 2015, 22: 319-329
Genomics, 2014, 103:122-134



Signaling network Analysis



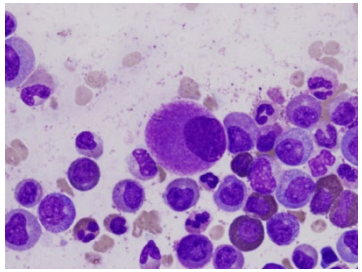
Promoter and Coding Region Structures

http://shenlab.sols.unlv.edu/shenlab/software/TSD/transcript_display.html

Bioinformatics, 2016, 32:2024-2025
Plant Cell Environ. 2017, 40:2004-2016

Molecular Basis of Leukemia

(in collaboration with Medical School, University of Chicago)



Cytogenetically normal refractory cytopenia with multilineage dysplasia (CN-RCMD)

Nature Communications, 2018, 9:1163
Leukemia, 2013, 27: 1291-1300

Research Group of Dr. Steffen

- **Dr. Jason H. Steffen**
- Associate Professor
- Department of Physics and Astronomy
- Email: jason.steffen@unlv.edu
- Website: jasonhsteffen.com

Expertise

- Understanding the properties of extrasolar planets and planetary systems
- Planetary dynamics
- Planet interior modeling
- Composition of planet-forming materials

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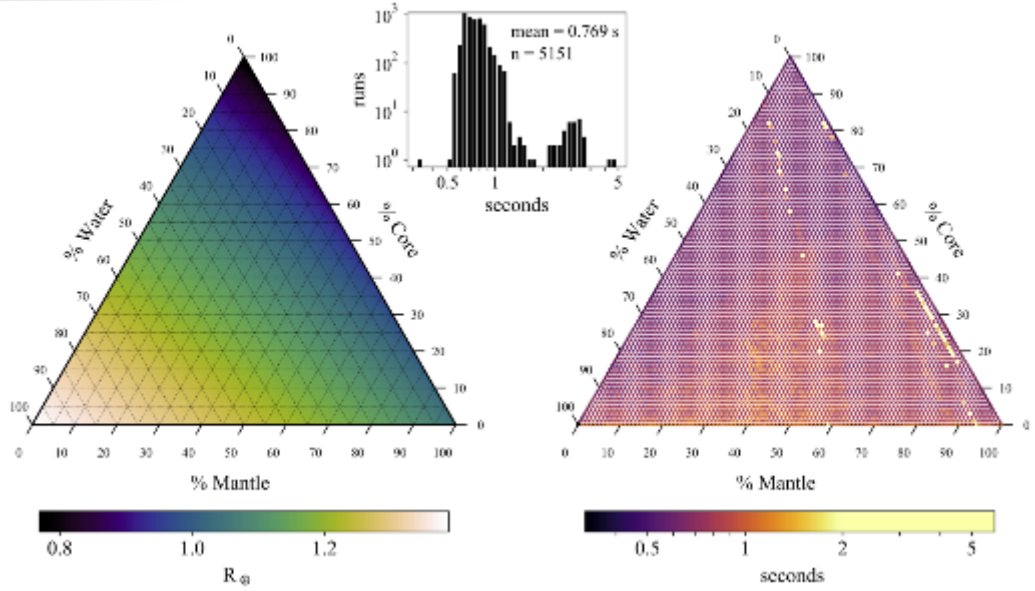
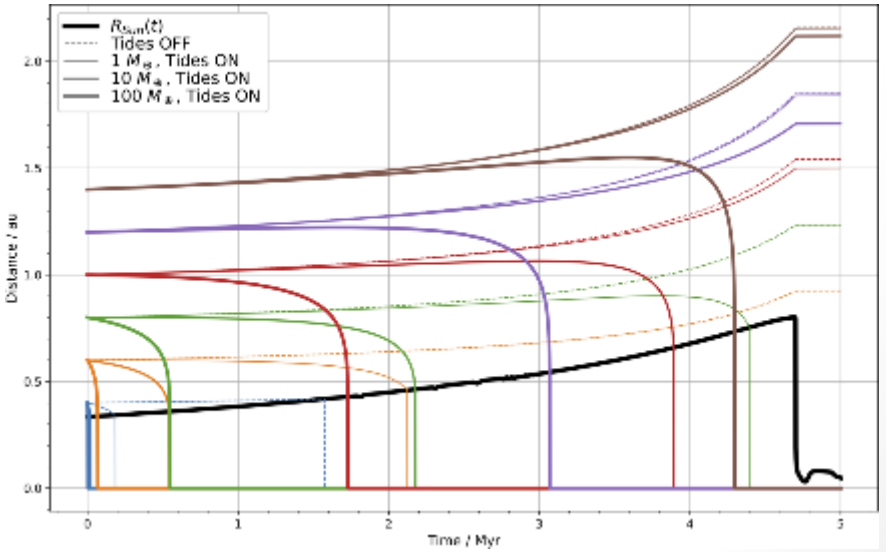


Timing results for planet models using the MAGRATHEA code, developed by our group at UNLV.

Future of planets in a system during the late stages of stellar evolution, including the effects of tides and stellar mass loss.



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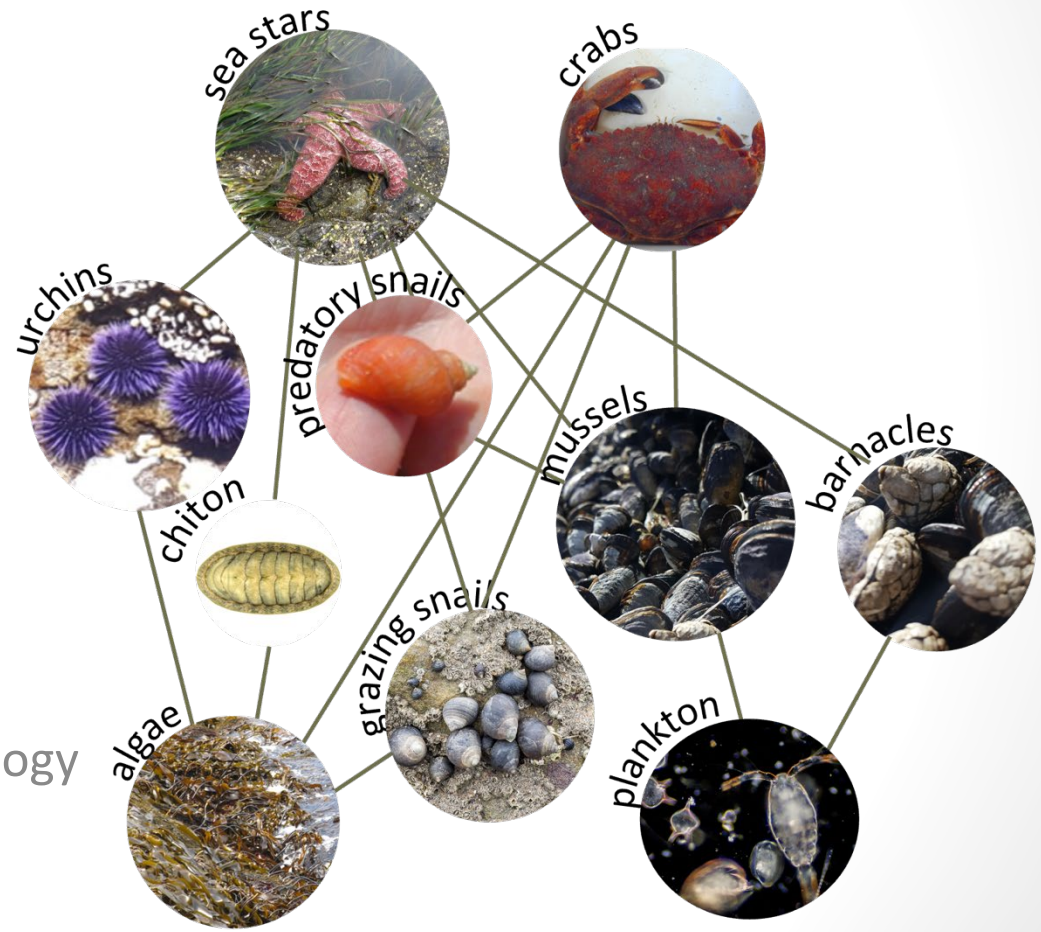
Paleoecology

- **Dr. Carrie L. Tyler, Ph.D.**
- Assistant Professor
- Department of Geoscience
- Email: carrie.tyler@unlv.edu
- Website: www.carrietyler.com

Expertise

- Marine invertebrates
- Taphonomy
- Food webs
- Conservation Paleobiology
- Predation



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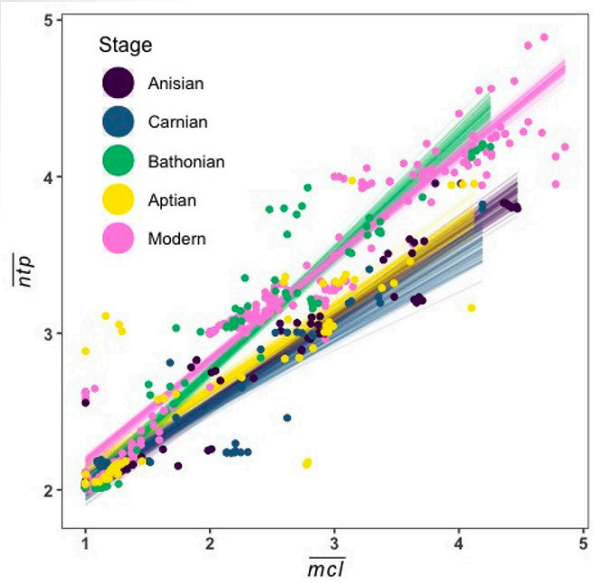


Marine food web structure from the Bathonian Stage (168 mya) resembles a modern Jamaican reef, but not the ecosystem before or after it.

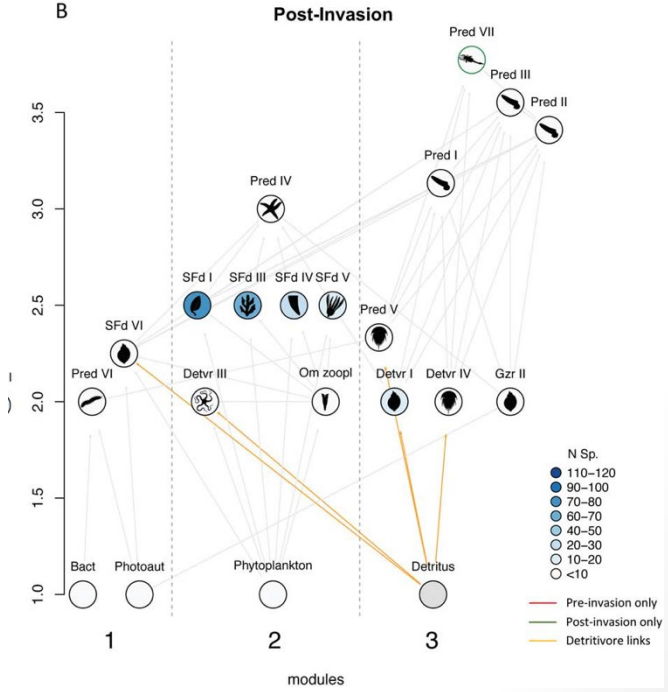
A better understanding of trophic position is needed for restoration planning, as communities may be so severely altered that restoring species or interactions may no longer be possible.

Banker *et al.* 2022 https://doi.org/10.3389/fevo.2022.983374

Fossil food webs before and after an invasion show changes in ecosystem dynamics, and invaders destabilized the ecosystem.

Conservation efforts may need to focus on preserving functional diversity if more diverse ecosystems are not inherently more stable.

Kempf *et al.* 2020
https://doi.org/10.1017/pab.2020.26



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Multi-Messenger High Energy Astrophysics

Dr. Bing Zhang
Department of Physics and Astronomy
Phone: (702)895-4050
Email: zhang@physics.unlv.edu, bing.zhang@unlv.edu

Expertise:

Theoretical astrophysics

Transients (gamma-ray bursts, fast radio bursts, etc) astrophysics

Multi-messenger (EM, gravitational waves, neutrinos, etc) astrophysics

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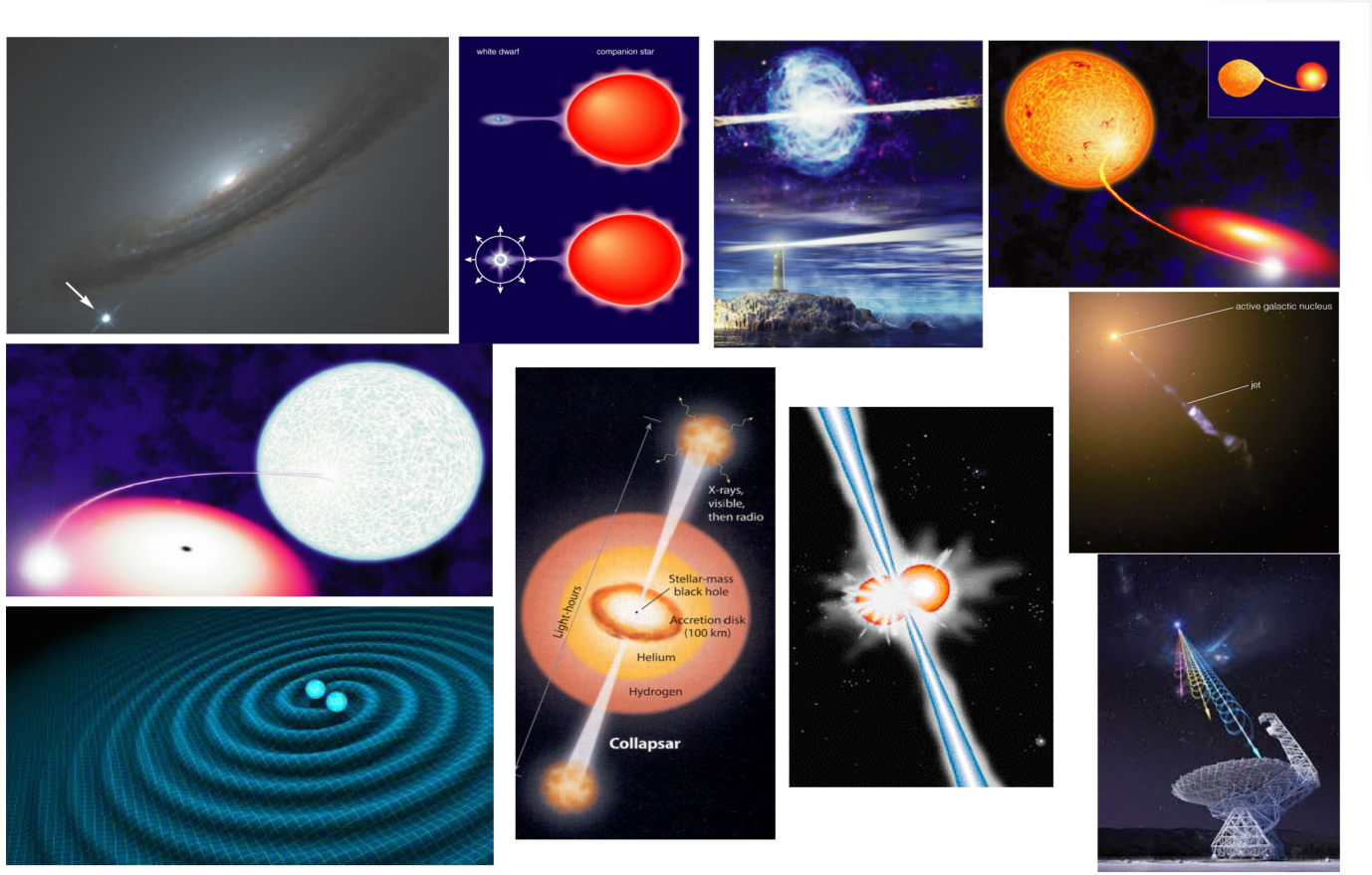
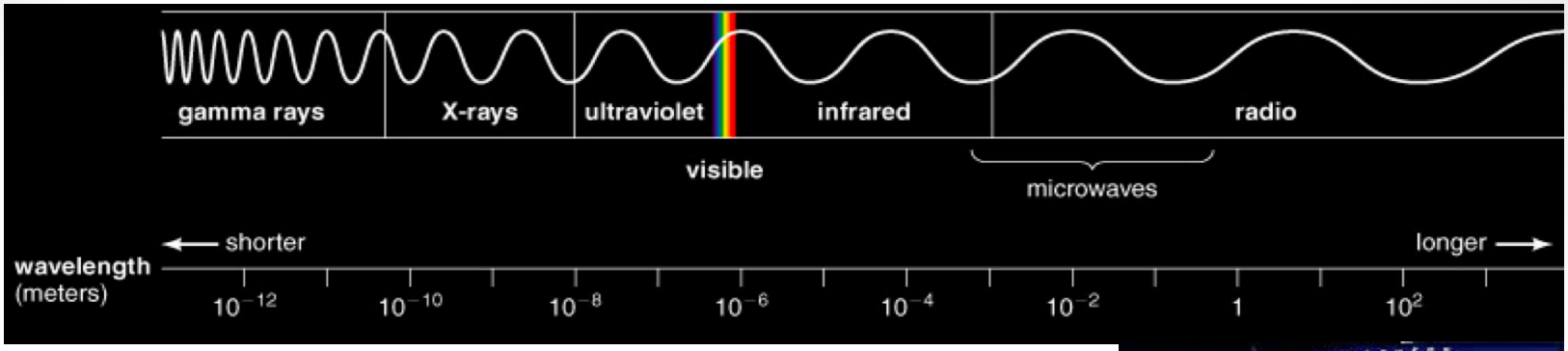
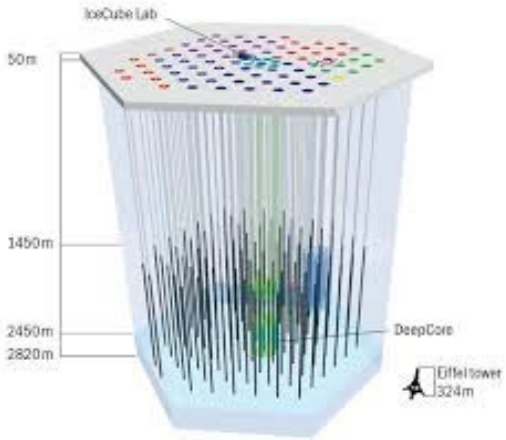


- Dr. Zhang's research covers a broad spectrum in high-energy astrophysics. He studies black holes of different scales, neutron stars of different species, and intense jets they launch. He is most actively working on the following three directions:
  - Gamma-ray bursts (the most luminous explosions in the universe)
  - Electromagnetic counterparts of gravitational waves
  - Fast radio bursts (a mysterious type of radio bursting signal)



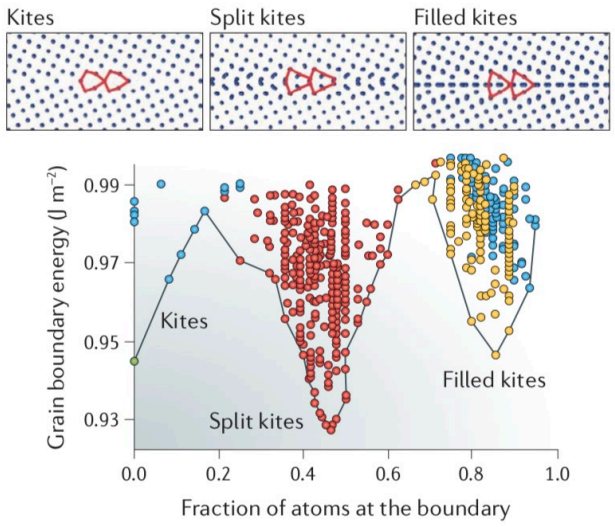


- In terms of observational data, Dr. Zhang's theoretical work make use of multi-wavelength and multi-messenger data:
  - Multi-wavelength: across the entire electromagnetic spectrum (from MHz radio waves to TeV gamma-rays)
  - Multi-messenger: Besides the traditional electromagnetic radiation, also include gravitational waves, neutrinos, and cosmic rays.

Qiang Zhu (Structure Prediction Aided by Artificial Intelligence)

USPEX Computational Materials Discovery

PyXtal



- Develop open source codes (USPEX, PyXtal)
- Predict the atomic structure of materials from first-principles
- Applicable to a range of materials (for both bulk and defects) under extreme conditions where experimental characterization is limited

Zhu, et al, Nat. Comm., 2018

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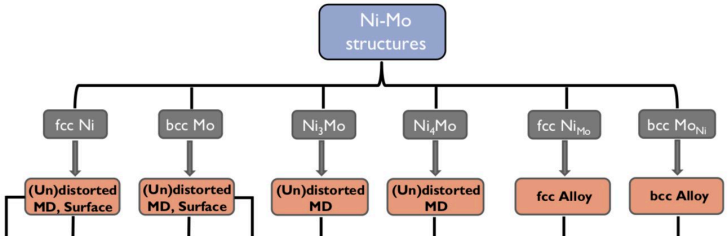
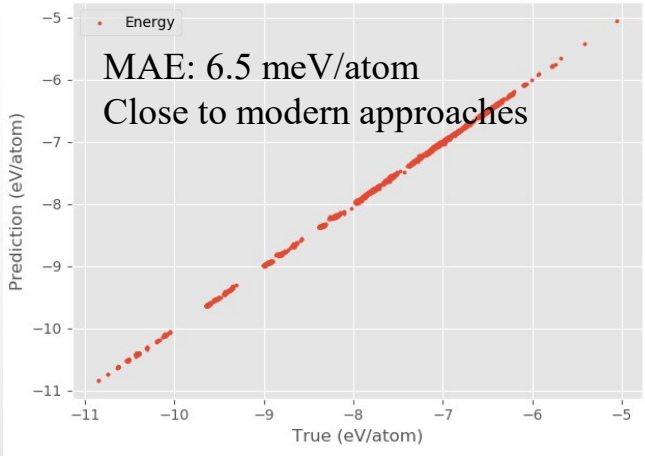
Qiang Zhu (Material Informatics & Big Data Analytics)





- Perform high throughput simulations to investigate materials based on target properties
- Publish online database with all computational details
- Develop machine learning interatomic potentials to enable large scale atomistic simulation (PyXtal_FF)

An example of training force field on Ni-Mo alloys

Qiang Zhu (Select Publications)

- Yanxon H, Zagaceta D, Wood B, Zhu Q*, On Transferability of Machine Learning Force Fields: A case study on silicon, arXiv, 2020
- Zhu Q*, Frolov T, Choudhary K, Computational Discovery of Inorganic Electrides from an Automated Screening, Matter, 2019
- Oganov A.R, Pickard C.J., Zhu Q and Needs R.J., Structure Prediction Drives Materials Discovery, Nature Review Materials, 2019
- Zhu Q*, Samanta A, Li B, Rudd R.E and Frolov T. Predicting Phase Behaviors of Grain Boundaries with Evolutionary Search and Machine Learning, Nature Communication, 2018
- Xu W, Zhu Q*, Hu CT, Structure of Glycine Dihydrate: Its implications to crystallization of glycogen from solution and modification of glycine in space, 2017
- Zhu Q, Shtukenberg A.G. et al, Resorcinol crystallization from the melt: a new ambient phase and new riddles, JACS, 2016
- Zhu Q*, Jung D.Y., Oganov A.R. et al, Stability of xenon oxides at high pressure, Nature Chemistry, 2013
- Zhu Q*, Oganov A.R., Glass C.W., Stokes H, Constrained evolutionary algorithm for structure prediction of molecular crystals: methodology and applications
- Full list is available at http://scholar.google.com/citations?user=1vO0eS0AAAAJ&hl=en

Astrophysical Fluid Dynamics

Dr. Zhaohuan Zhu

Department of Physics and Astronomy

Phone: (702) 895- 3563

Email: zhaohuan.zhu@unlv.edu

Expertise:

Fluid dynamics for astronomical project

Star and planet formation

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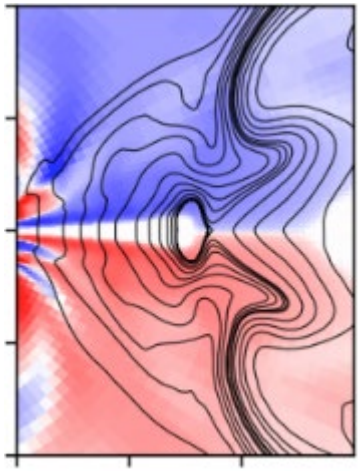
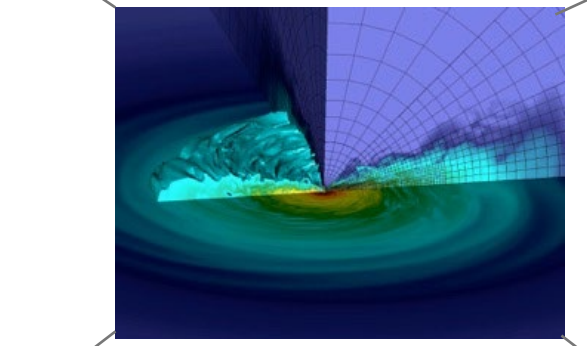
Fluid dynamics:

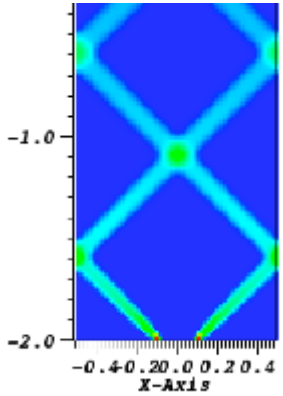
- Developing and using the state of the art numerical code to solve astrophysical fluid problem.

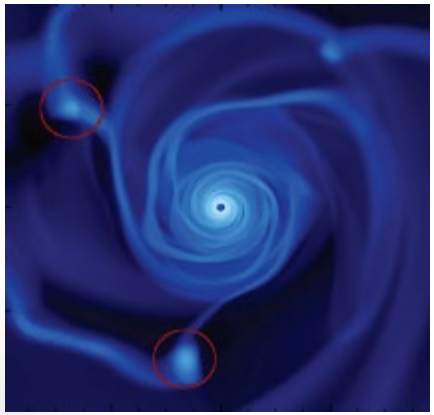


Magnetic field

Radiation

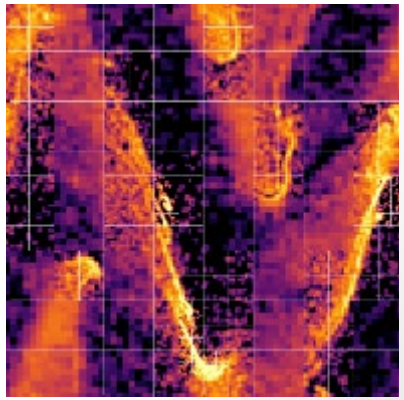






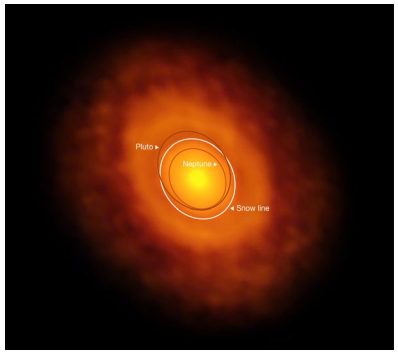
gravity

particles



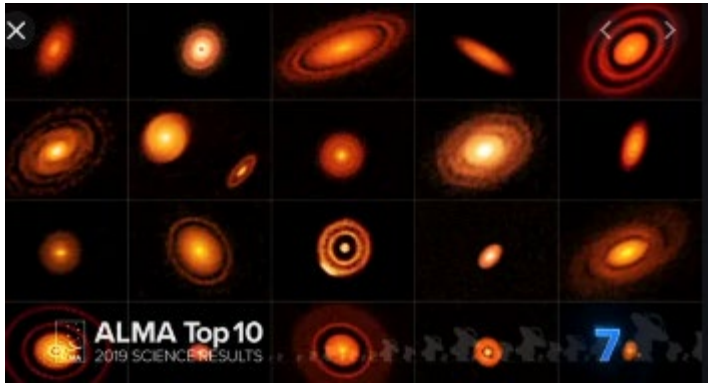
Star and planet formation:

- Protoplanetary disk dynamics:



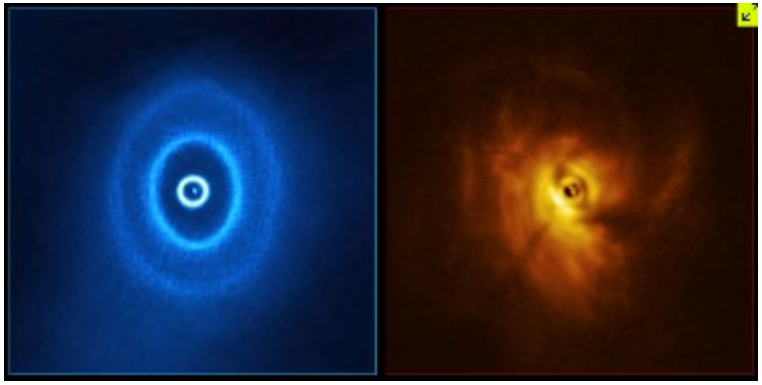
V883 Ori, *Nature*

- Planet formation



DSHARP

- Planet-disk interaction



GW Ori, *Science*