



**MONTCLAIR STATE**  
**UNIVERSITY**

# **Department of Physics & Astronomy**

## *Open House Presentation*



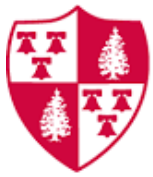
**Marc Favata**

Department Chairperson &  
Associate Professor of Physics

<https://www.montclair.edu/physics-astronomy/>



# Welcome to Montclair State!



**MONTCLAIR STATE**  
UNIVERSITY



1. What is Physics?
2. What do you do with a Physics degree?
3. Why should you study Physics at Montclair State.

Following presentation:

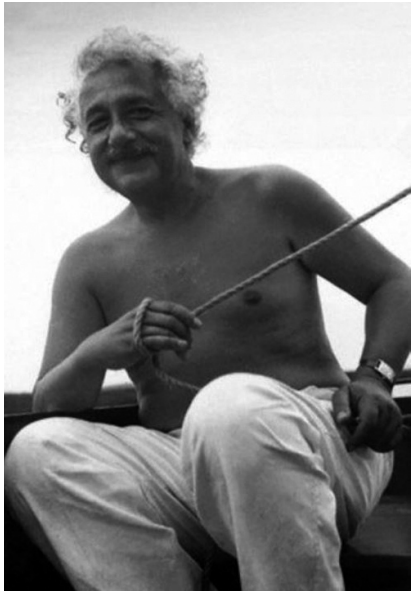
- Time for questions
- discussion with students
- lab tours (if in-person)





# What is physics?

Physics comes from the ancient Greek word for...  
***nature.***



The main objective of physics is to ***discover the fundamental principles of nature*** or the mathematical laws that govern the behavior of a complex physical system.

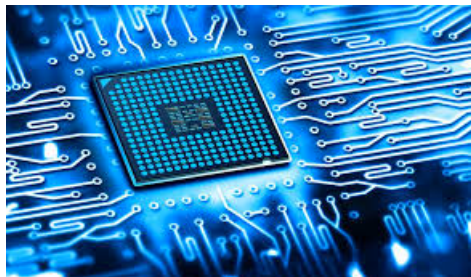
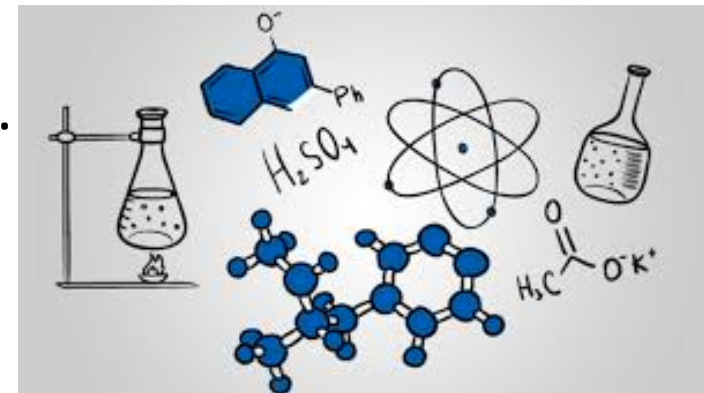
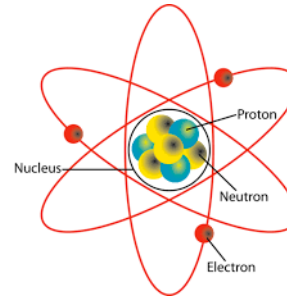
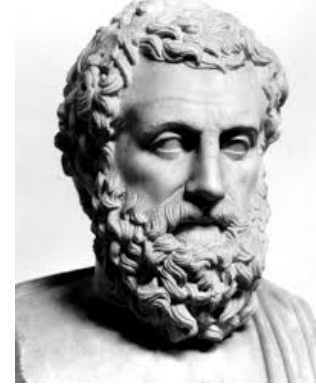
I.e., Physics explains *how* everything works at the most fundamental level.



# What is physics?

## Physics...

- is one of the oldest academic disciplines.
- studies nature from the scale of atoms to galaxies and beyond.
- is the cornerstone of all natural sciences (chemistry, biology, geology, astronomy).
- is the basis of our modern technological society.

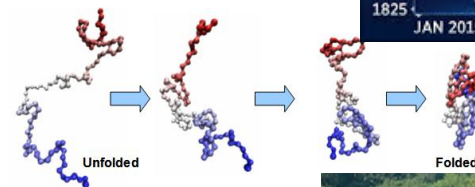
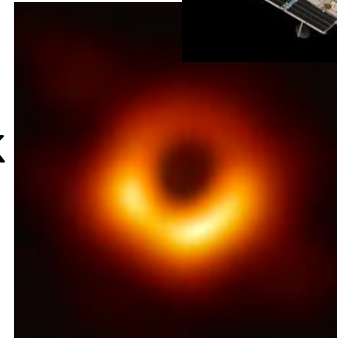
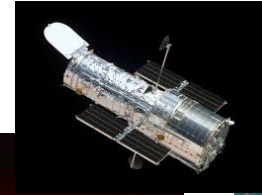




# What is physics?

## Examples of what physicists study include...

- The fundamental nature and behavior of matter (protons, quarks, electrons, neutrinos, phase changes, superconductivity...)
- The behavior of black holes, galaxies, dark matter, the expansion of the universe.
- The behavior of complex systems (the stock market, bacteria locomotion, *disease transmission*, protein folding, motion of many-planet star systems, ...)
- Issues related to defense, national policies (nuclear weapons, climate science, energy policy, space exploration ...)





# What do you do with a physics degree?

## Physics is a skills-based degree.

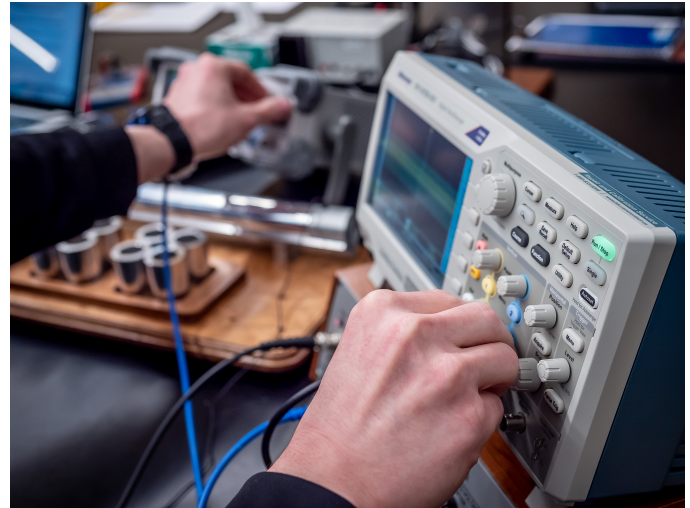
The “value” of a physics degree comes from the skills that are imparted.

Primarily, a physics education provides you with a sharp mind and superior problem-solving abilities.

*You should study physics because because you are passionate about understanding how the world works at a fundamental level.*

## Common skill set of physics majors:

- technical problem solving and critical thinking
- quantitative analysis, data analysis
- knowledge of advanced mathematics
- working with laboratory instruments
- proficiency with computer hardware/software (e.g., Python, Java, C/C++, Excel, Labview, Matlab, Maple/Mathematica, web design/html/css, LaTeX, ...)
- communicating complex ideas; technical writing and oral presentation
- conducting research
- working in teams

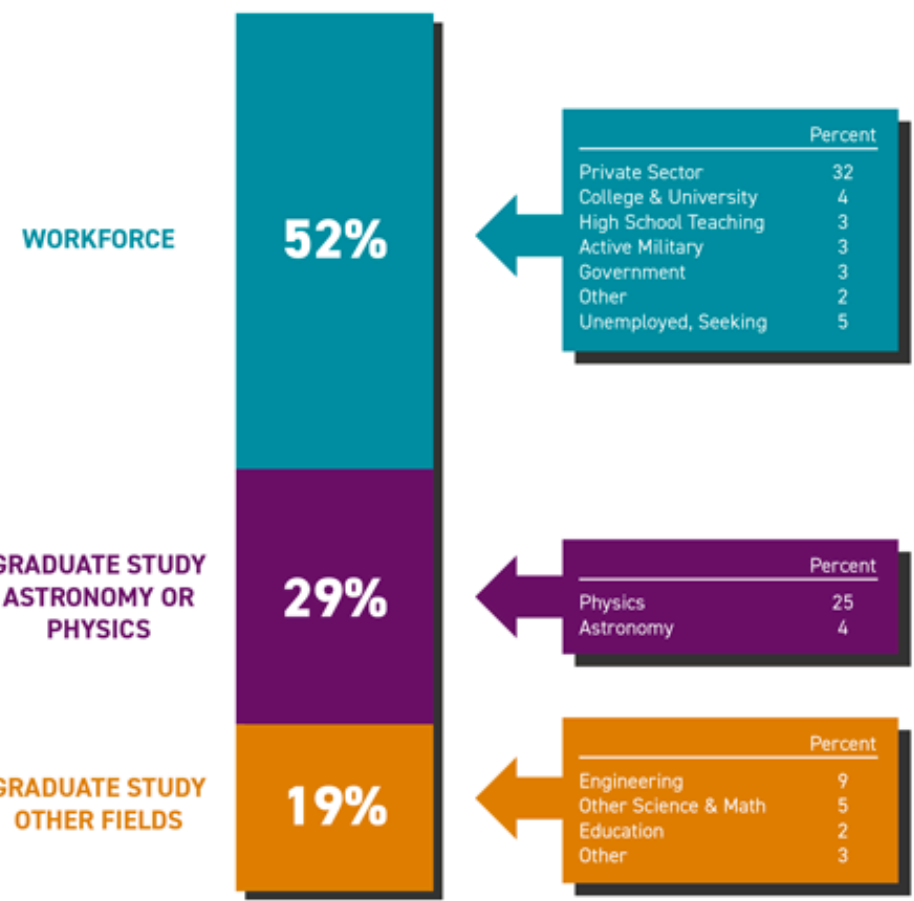




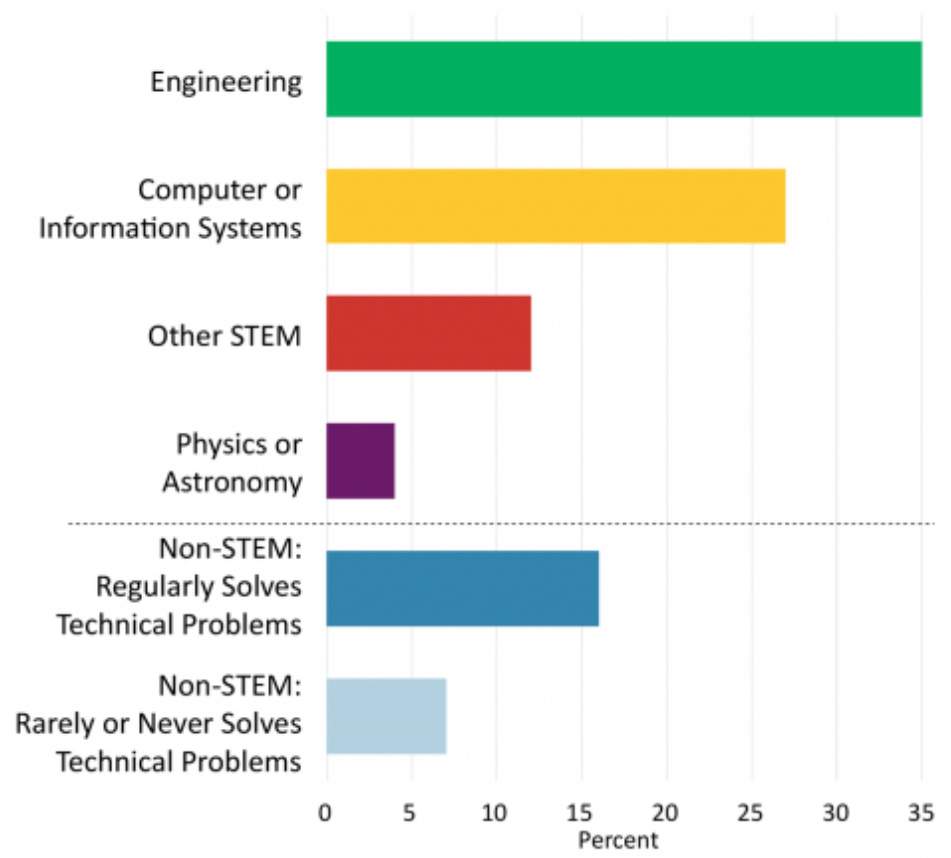
# What do you do with a physics degree?

## Physics Bachelors 1 Year Later

8,800 Recent Degree Recipients



## Field of Employment for New Physics Bachelors Employed in the Private Sector

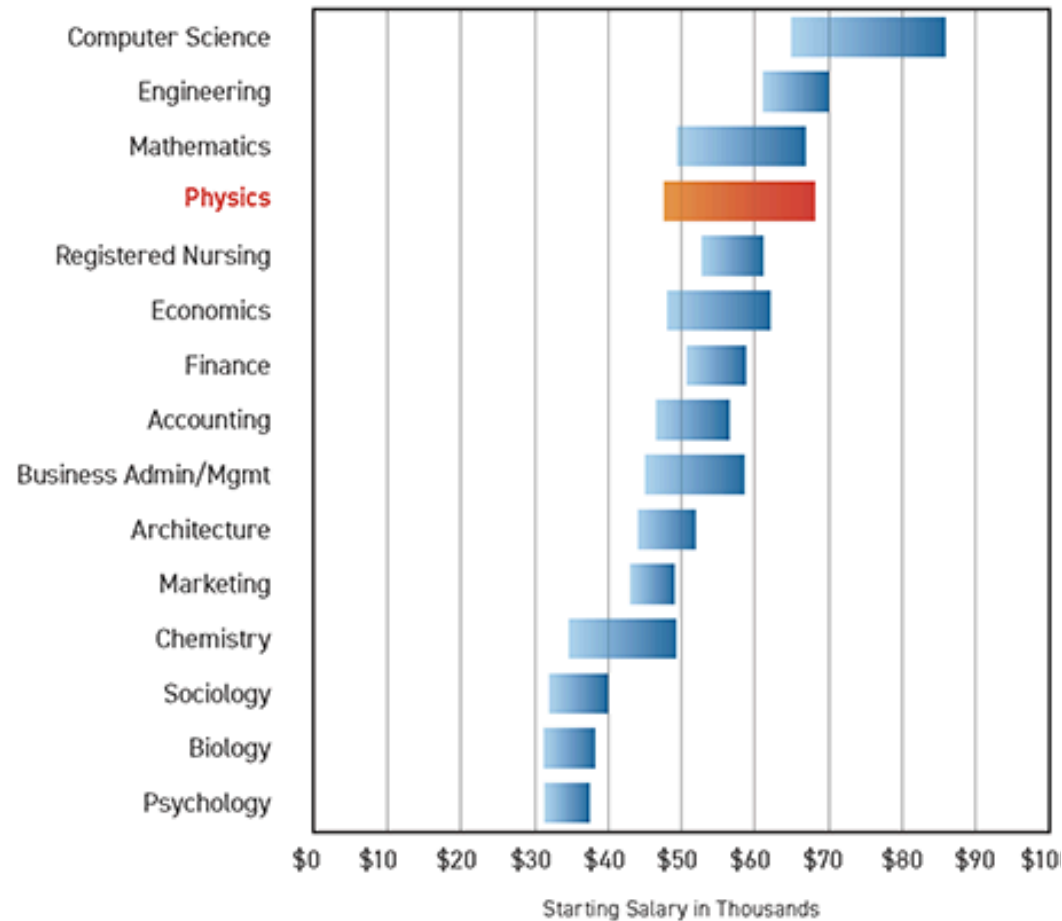


# What do you do with a physics degree?

## Common fields of employment for physics majors:

- engineering
- computer industry (hardware or software)
- finance
- defense/aerospace industry
- astronomy/physics research (private or government labs)
- teaching or research at the university/college level
- medicine & law
- teaching (elementary/high school)
- management consulting
- journalism & publishing industry
- anywhere good problem-solving skills are required

## What Do New Bachelors Earn? Starting Salaries for the Class of 2018





# What do you do with a physics degree?

## Medicine and Law:

Physics majors have among the highest MCAT and LSAT scores.

Average MCAT Scores\* by Selected Majors, 2012

	Physical Science	Biological Science	Verbal Reasoning	Number of Applicants
Economics	10.8	10.8	9.9	633
<b>Physics</b>	<b>11.1</b>	<b>10.4</b>	<b>9.8</b>	<b>228</b>
Biomedical Engineering	11.1	10.6	9.6	1,147
Mathematics	10.6	10.4	9.3	340
Electrical Engineering	10.9	10.1	9.4	135
Neuroscience	10.1	10.6	9.5	1,615
English	9.6	10.1	10.2	380
Biochemistry	10.1	10.4	9.0	2,864
Chemistry	9.5	10.0	9.0	2,113
Microbiology	9.2	10.1	8.8	759
Psychology	9.1	9.6	9.1	2,327
Biology	9.0	9.7	8.7	13,605
Premedical	8.3	8.9	8.1	587
<b>All Majors</b>	<b>9.5</b>	<b>9.9</b>	<b>9.0</b>	<b>44,464</b>

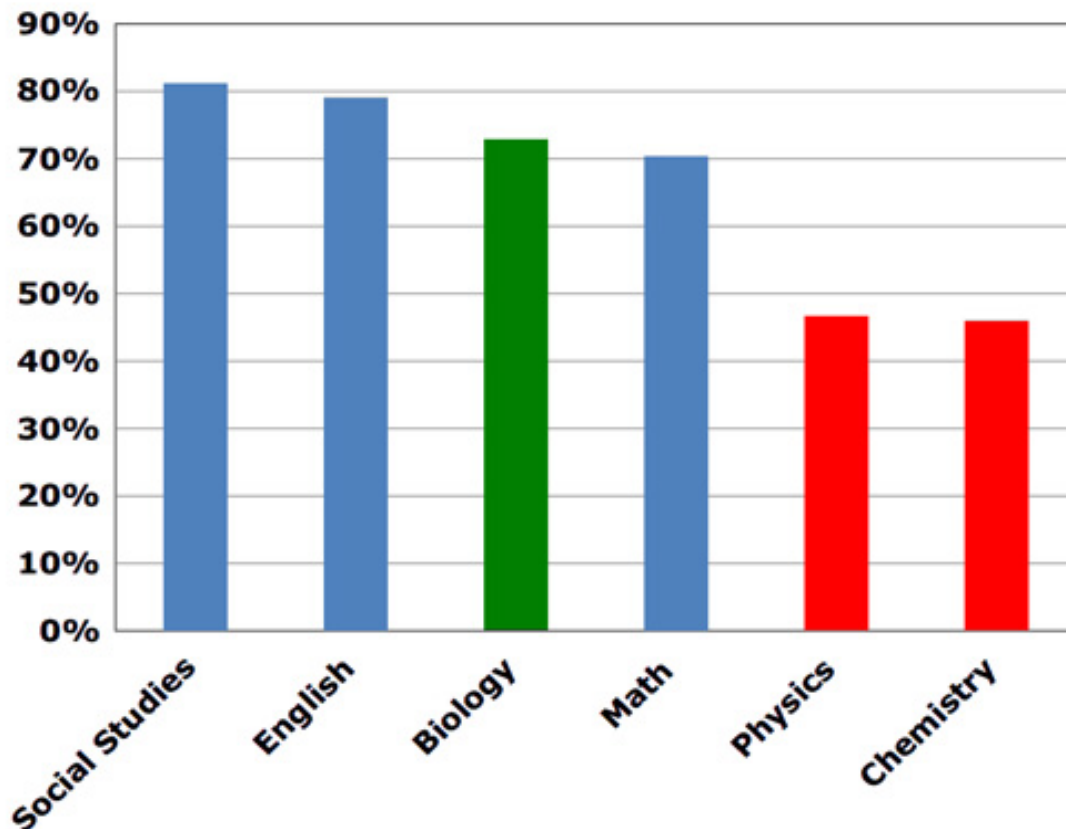
Average LSAT Scores\* by Selected Majors, 2012

	Average Score*	Number of Applicants
Mathematics	162.2	254
<b>Physics</b>	<b>162.1</b>	<b>126</b>
Economics	159.1	2,468
Engineering	157.3	1,127
Chemistry	156.7	267
History	156.7	3,323
English	155.8	3,728
Biology	155.2	1,095
Political Science	154.3	12,215
Psychology	153.3	3,335
Computer Science	152.3	327
Pre-Law	149.0	994
Criminal Justice	145.3	2,878
<b>All Majors</b>	<b>153.6</b>	<b>66,197</b>

# What do you do with a physics degree?

There is a large need for ***qualified physics teachers***, especially in NJ.

Fraction of high school classes taught by teacher w/ degree in that subject.



Montclair State is well-known throughout NJ for its excellent teacher preparation program.

We offer multiple options for teacher certification.

Our physics teacher education students have a great track record at landing teaching jobs in high-paying school districts.



# Famous people who studied physics:

- *Elon Musk*, CEO of Tesla Motors, SpaceX, SolarCity, Paypal founder.
- *Tim Berners Lee*, creator of the World Wide Web
- *Jimmy Carter*, 39<sup>th</sup> US President
- *Sally Ride*, first American woman in space.
- *Brian May*, lead guitarist for Queen
- *Angela Merkel*, prime minister of Germany
- *Ehud Barack*, former Israeli prime minister
- *Boris Nemtsov*, murdered Russian opposition leader
- *Steven Chu*, Sec. of Energy for Pres. Obama; Nobel in physics
- *Ashton Carter*, Sec. of Defense for Pres. Obama
- *France Cordova*, NSF director
- *Rush Holt*, NJ congressman (D)
- *Vernon Ehlers*, congressman (R)
- *Bill Foster*, congressman (D)
- *Mike Judge*, creator of Beavis & Butt Head and King of the Hill
- *James Cameron* (did not complete degree, switched to english?); director of Terminator, Titanic, Avatar, Rambo II, Abyss, Aliens, Terminator 2, True Lies
- *Paul Verhoeven*, filmmaker, director of Basic Instinct, Starship Troopers, Robocop, Total Recall, Showgirls



*physics @ montclair*



**WE WANT YOU**



# Physics Faculty



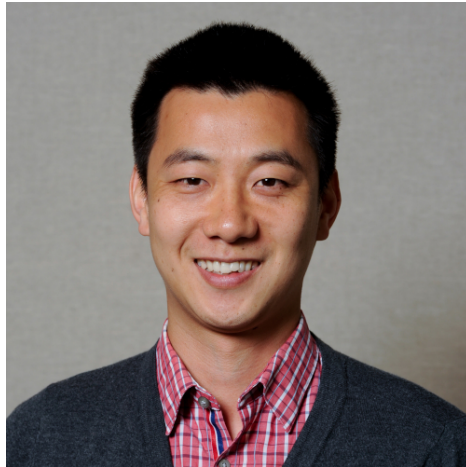
Marc Favata  
(gravitational-waves, astro.)



Shaon Ghosh  
(gravitational-waves, astro.)



Dean Hamden  
(physics education)



Kent Leung  
(nuclear physics, joining 2021)



Rodica Martin  
(gravitational waves, optics)



Ashwin Vaidya  
(affiliated faculty, fluid mech.)

# Physics degree options:

- **BS in Physics**
- BS in Physics, Astronomy Concentration (requires 2 extra electives)
- **BS in Physics, Pre-med Concentration** (no PHYS464, 2 electives, 6 additional BIO/CHEM courses)
- **BS in Physics, Teacher Certification in Physics, pre-K to 12**  
(only one PHYS elective, and reduced Gen. Ed., but 37 credits of teacher ed. courses).
- **BS in Physics, Teacher Certification in Physical Science Teacher, pre-K to 12**  
(same as above, but no PHYS 464, no ODEs, and 3 additional CHEM courses).
- **BS Physics + MS in Applied Mathematics (5-yr BS/MS program)**
- **BS Physics + MS Mechanical Engineering**  
(5-yr dual degree program with Stevens Institute of Tech).
- **Physics Minor**

*Starting Fall 2020:*

- **BS Physics/Master of Arts in Teaching**  
(5-yr dual degree and teacher certification)
- **BS Physics/Masters in Business Administration**  
(BS+MBA; 5yr program)

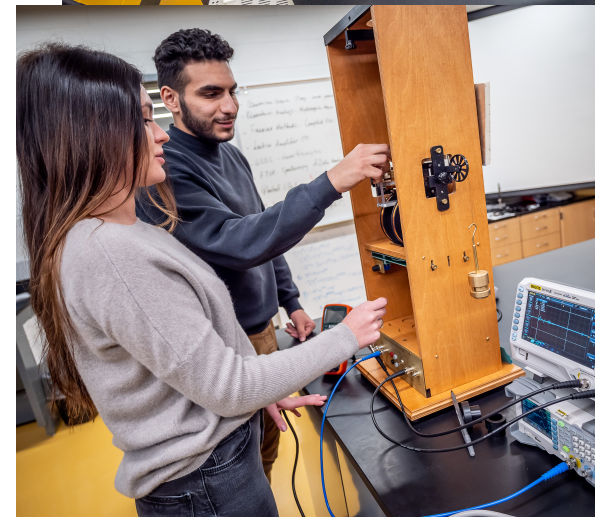
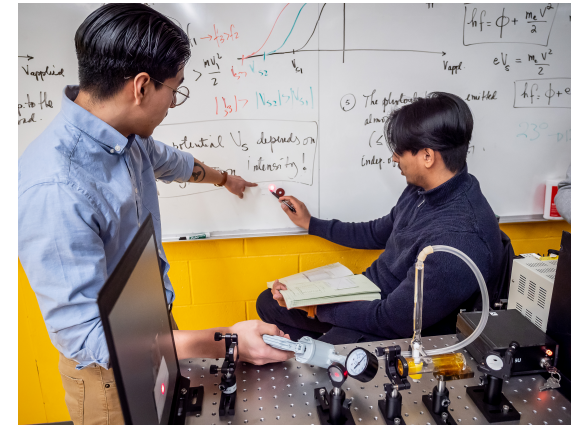




# New curriculum:

## Emphasizes:

- *lab experiences:*
  - “classic” physics labs in mechanics, E&M, optics, atomic, and nuclear physics.
  - data analysis
  - working with lab instruments (function generators, oscilloscopes, op-amps)
- *seminars courses:*
  - preparing for success in the major
  - prep for future math/physics classes
  - lectures on state-of-the-art advances
  - career preparation
  - computing skills
- *coverage of all major areas of physics* (grad school preparation)
- *soft skills:* writing, oral presentation, teamwork
- *broad knowledge in science* (chemistry, math, computing)





## Core physics requirements (all BS degrees):

Year 1, Fall	Year 1, Spring
PHYS 191-University Physics 1 GNED 199-New Student Sem. (freshmen only) MATH 111 (Precalc) or 122 (Calculus 1)	PHYS 192-University Physics 2 PHYS 198-Intro. Physics Seminar MATH 122-Calculus 1 or MATH 221-Calculus 2; <i>(take Calculus 2 during summer session if needed).</i>
Year 2, Fall	Year 2, Spring
PHYS 210-Intermediate Mechanics MATH 222-Calculus 3	PHYS 340-Electricity & Magnetism PHYS 320-Statistical and Thermal Physics AMAT 350 – Applied Math 1 (or alt. diff. eq. course)
Year 3, Fall	Year 3, Spring
PHYS 220-Oscillations, Waves, Optics PHYS 230-Intermediate Physics Lab	PHYS 360-Modern Physics
Year 4, Fall	Year 4, Spring
PHYS 464-Quantum Mechanics PHYS 300-Junior/Senior Physics Seminar PHYS 330-Advanced Physics Lab	(+ 3 physics electives taken any semester according to prerequisites.)

- Can be taken in year 2 or year 3
  - Can be taken in year 3 or year 4
- Take courses when offered! Most courses are offered every other year.**  
**\*See curriculum guides for details.**

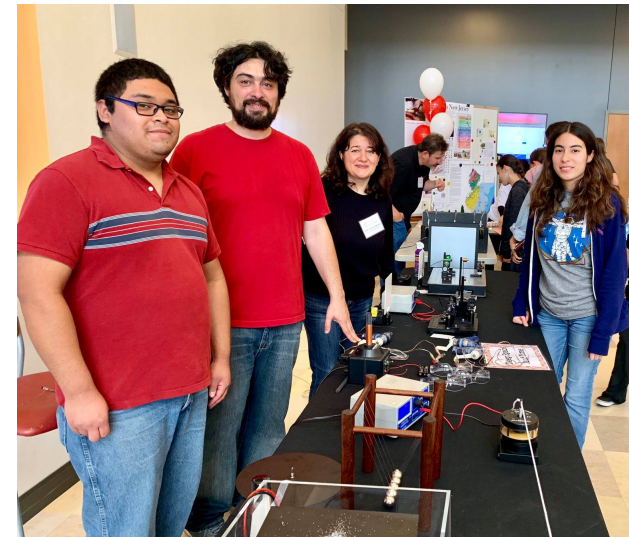
Take anytime, but as soon as possible after PHYS and MATH are scheduled:

- CSIT 104-Computational Concepts
- CHEM 120/121-General Chemistry 1 & 2.

# Department activities

## physics club & department seminars

- Wednesdays afternoons
- seminars on physics
- field trips
- career advice
- “physics day” & outreach events
- project building
- *free food!*



# Department activities



## public telescope night

- every clear Thursday @8pm (during semester)
- see the Moon, stars, planets, nebulae, star clusters, ...
- public astronomy lectures (2<sup>nd</sup> Wed. of the month)

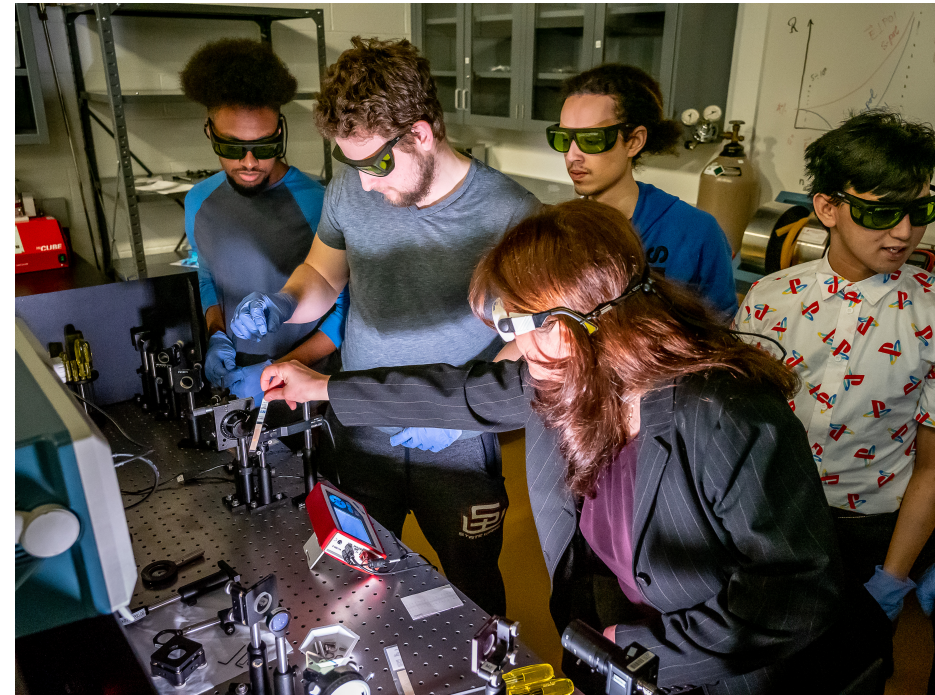
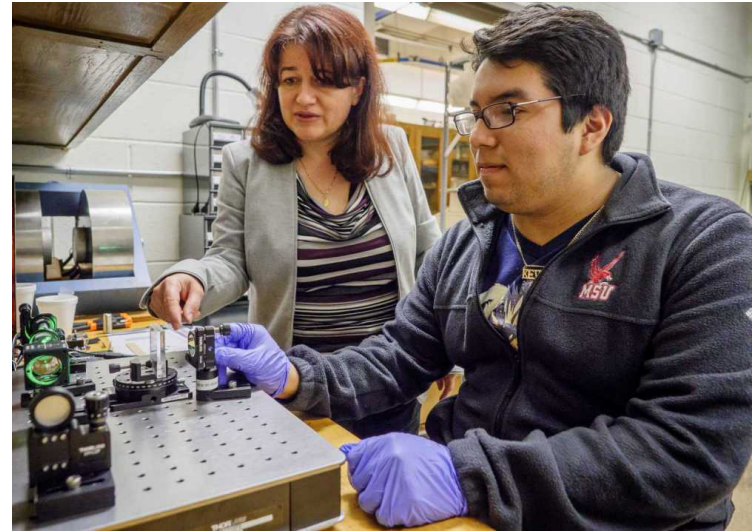




# Department activities

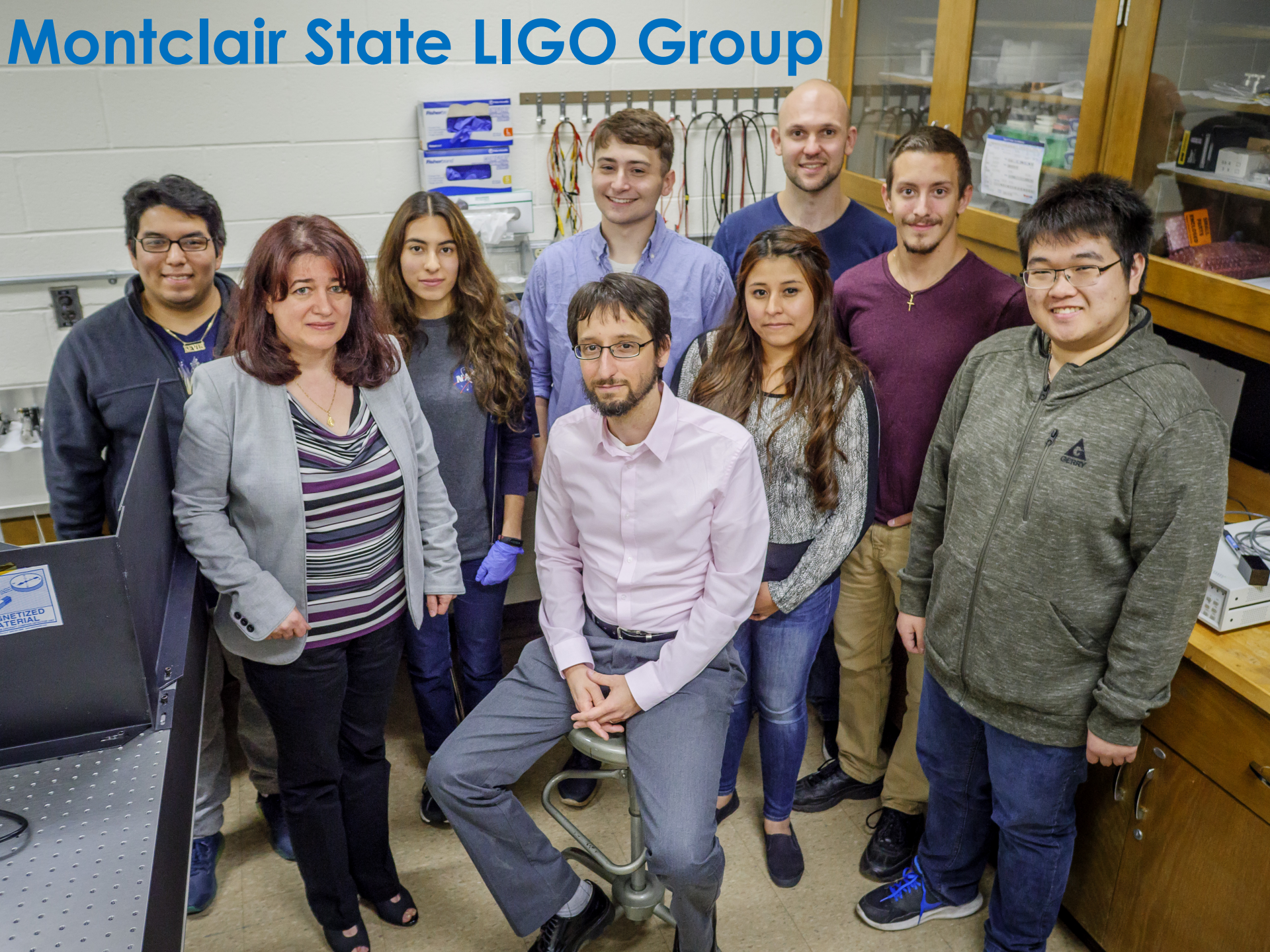
## student research

- projects in labs and other courses
- work on real grant-funded research leading to publication
- opportunities to present your work at conferences
- a variety of opportunities and internships are available



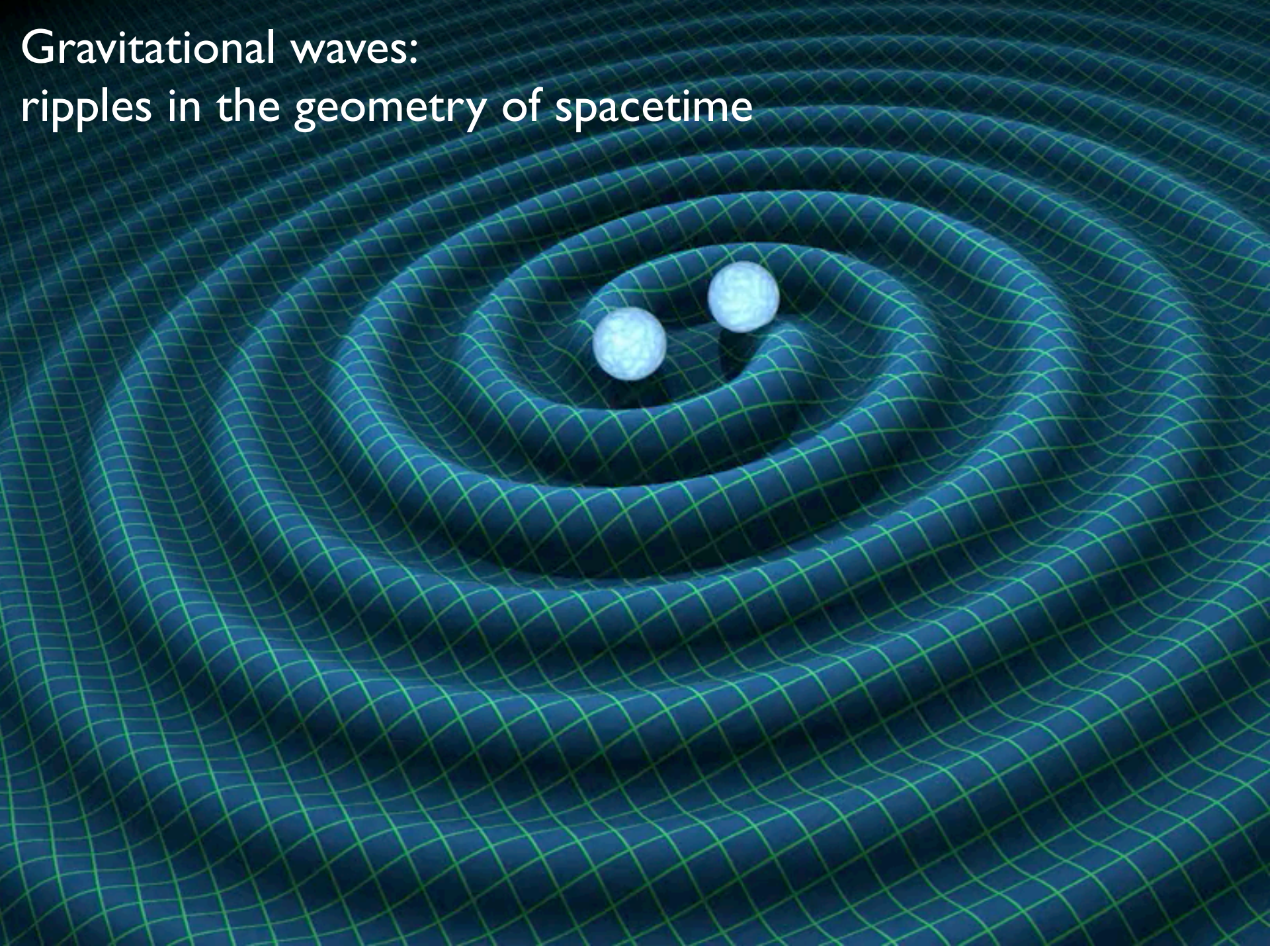


# Montclair State LIGO Group





Gravitational waves:  
ripples in the geometry of spacetime





# How we see the universe:

## Electromagnetic Wave Windows

X-Ray

Optical

Radio

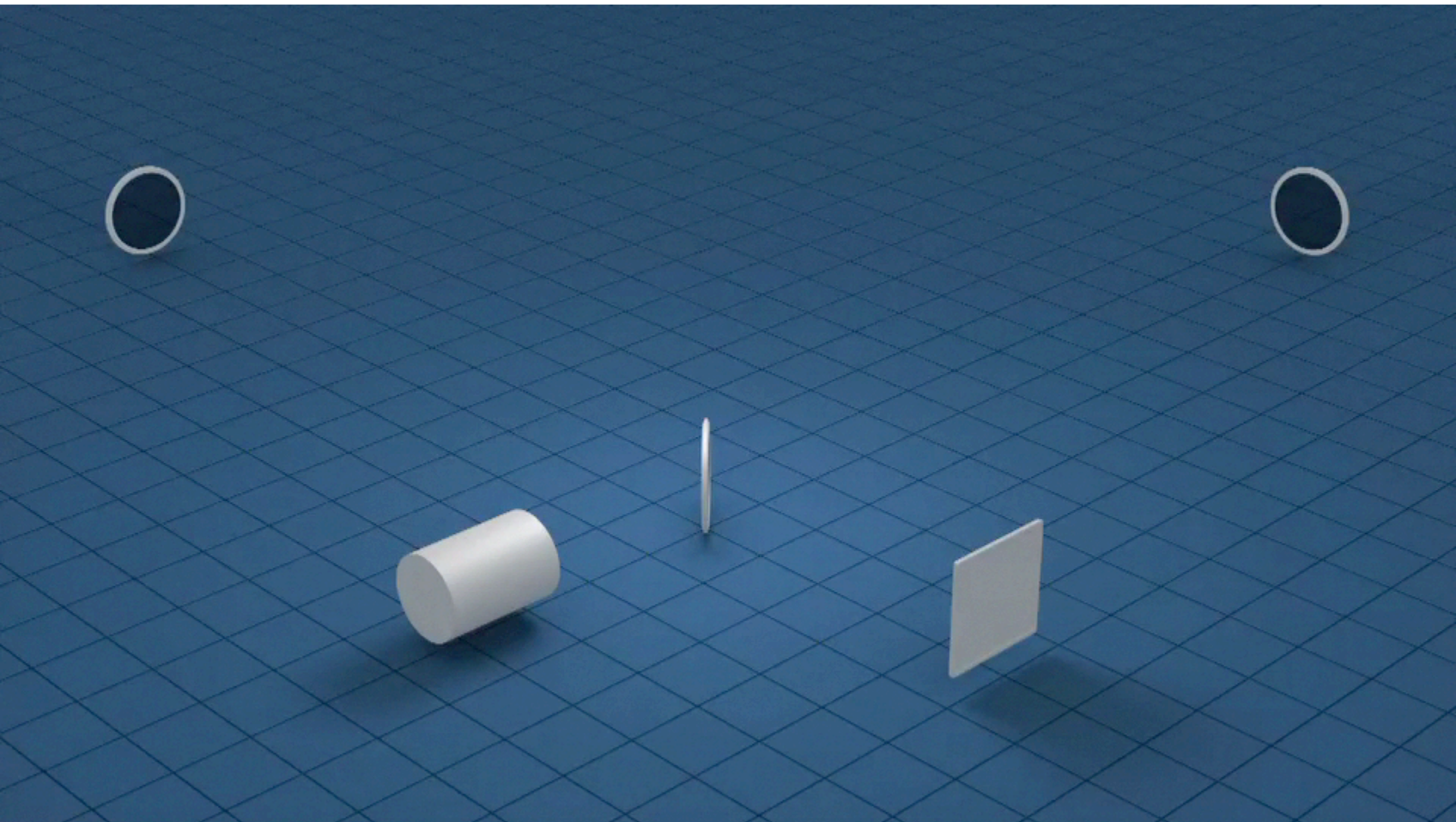


# LIGO: the *Laser Interferometer Gravitational-wave Observatory*



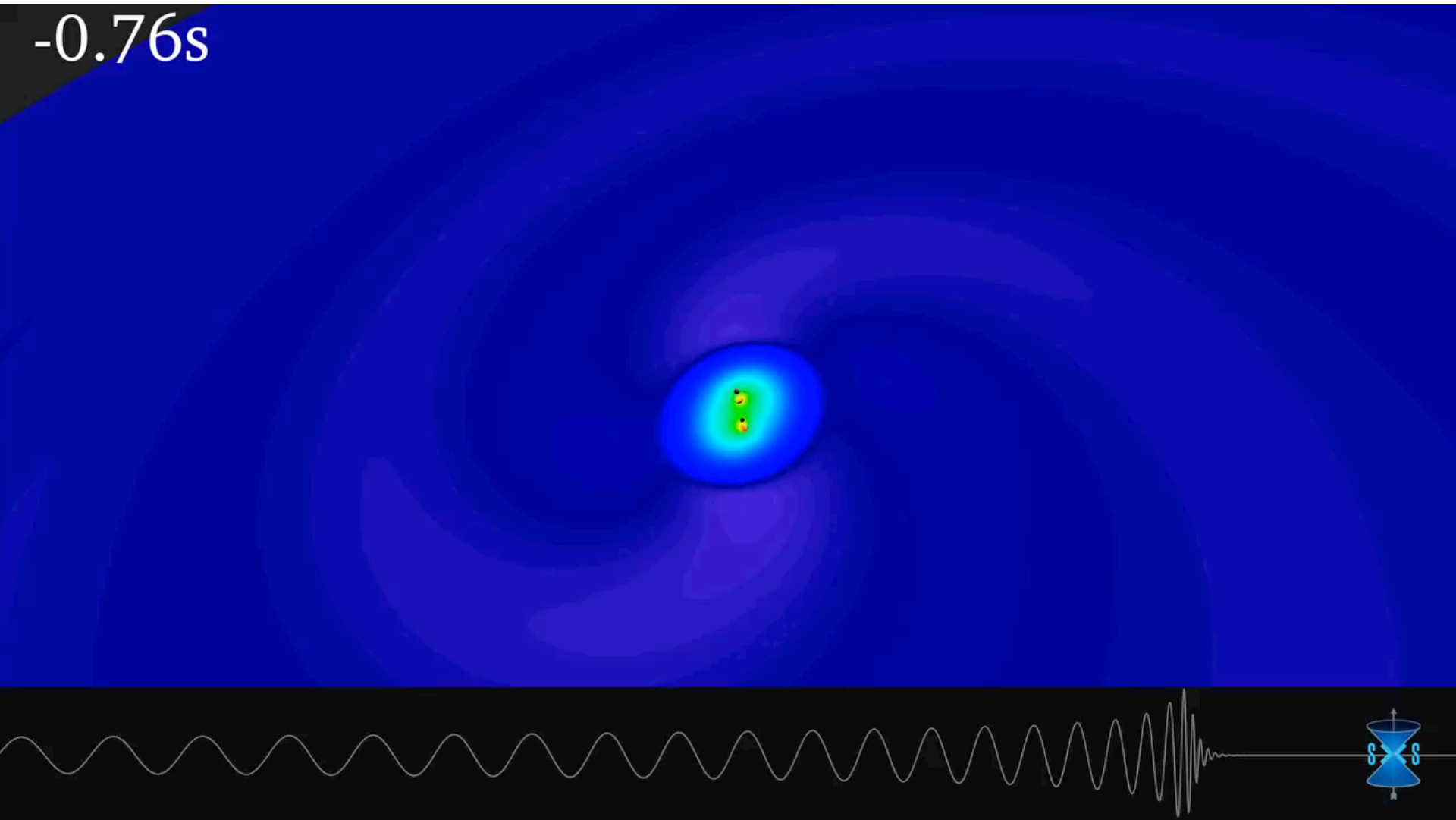


# LIGO: *how it works*



# *GW150914: first detection of a black hole collision*

-0.76s





# LIGO: the discovery

"All the News That's Fit to Print"

# The New York Times

VOL. CLXV . . . No. 57,140 +

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NEW YORK, FRIDAY, FEBRUARY 12, 2016

\$2.50

Clinton Paints Sanders Plans As Unrealistic



Home Moments

Search Twitter

Have an account? Log in

President Obama

@POTUS

Dad, husband, and 44th President of the United States. Tweets may be archived: [wh.gov/privacy](#).

Washington, D.C.

[WhiteHouse.gov](#)

Joined June 2013

Born on August 4, 1961

38 Photos and videos

Tweets

Tweets & replies

Photos & videos

President Obama

@POTUS · 3h

Einstein was right! Congrats to @NSF and @LIGO on detecting gravitational waves - a huge breakthrough in how we understand the universe.

1.9K

3.7K

...

President Obama

@POTUS · 10h

Way to ace your AP Calc test, Landon! You should come drop some knowledge at the White House Science Fair: [wapo.st/1RpdCk9](#)

967

3.9K

...

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Pope Francis

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Hillary Clinton

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The First Lady

...

WITH FAINT CHIRP, SCIENTISTS PROVE EINSTEIN CORRECT

A RIPPLE IN SPACE-TIME

An Echo of Black Holes Colliding a Billion Light-Years Away

By DENNIS OVERBYE

A team of scientists announced on Thursday that they had heard and recorded the sound of two black holes colliding a billion light-years away, a fleeting chirp that fulfilled the last prediction of Einstein's general theory of relativity.

That faint rising tone, physicists say, is the first direct evidence of gravitational waves, the ripples in the fabric of space-time that Einstein predicted a century ago. It completes his vision of a universe in which space and time are interwoven and dynamic, able to stretch, shrink and jiggle. And it is a ringing confirmation of the nature of black holes, the bottomless gravitational pits from which not even light can escape, which were the most fore-



Laser Interferometer Gravitational-Wave Observatory in Hanford, Wash.

acks Notice Sanders

South lists

candidate she barely knew. "It makes me feel good," she said, chucking, "that young people are listening to the elderly people." She now said she was an un-

Last Occupier In Rural Oregon Is Coaxed Out





Barry C. Barish (Caltech)



Kip S. Thorne (Caltech)



Rainer Weiss (MIT)



## 2017 Nobel Prize in Physics

“...for decisive contributions to the LIGO detector and the observation of gravitational waves.”

[https://www.nobelprize.org/nobel\\_prizes/physics/laureates/2017/](https://www.nobelprize.org/nobel_prizes/physics/laureates/2017/)

Three MSU faculty and two MSU students were co-authors on papers that led to this Nobel-prize-winning discovery.

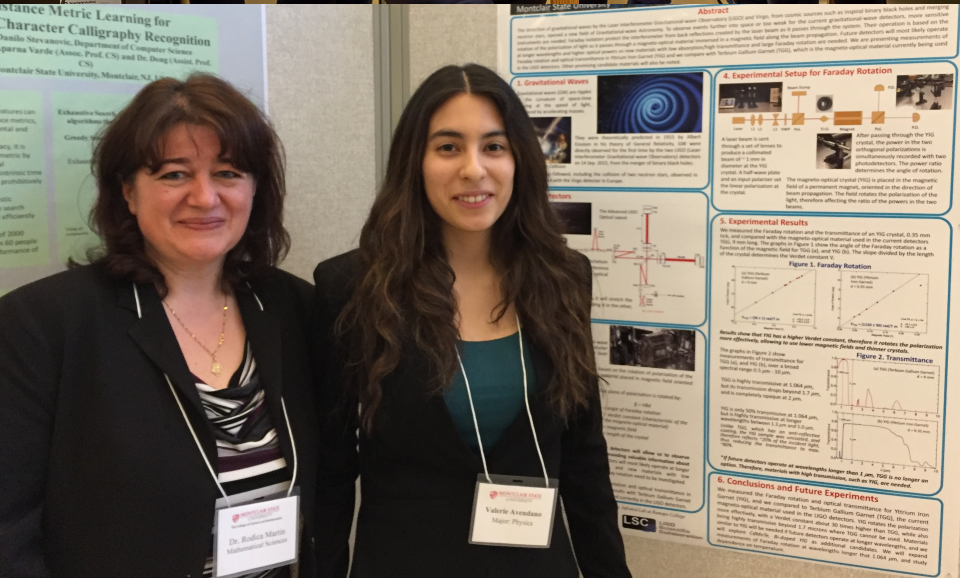
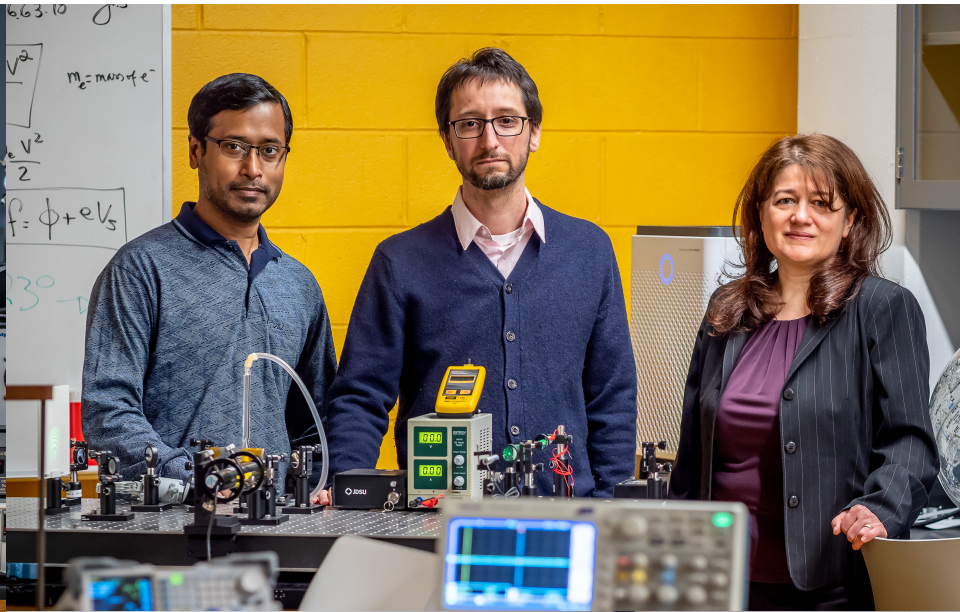
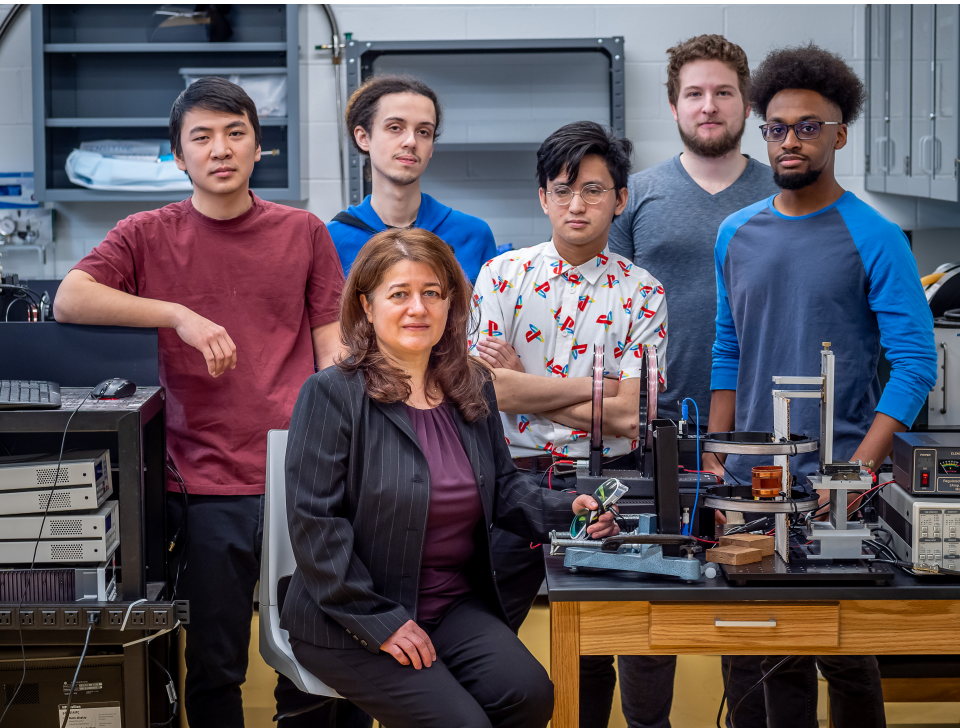




GW170817: first binary neutron star merger

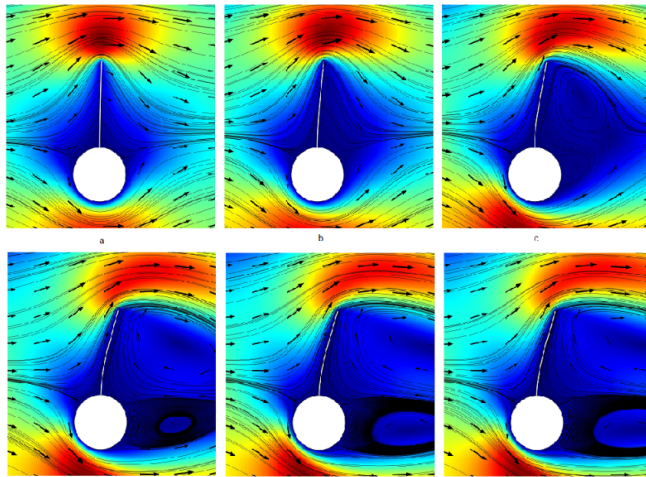


# Montclair State LIGO Group

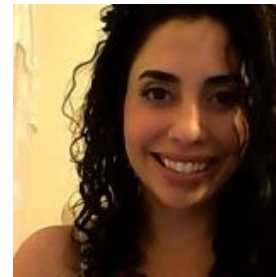
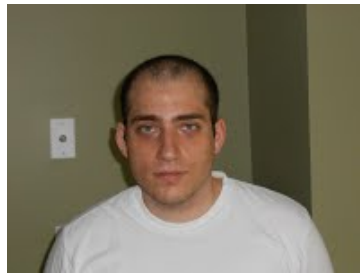




# Fluid Mechanics Research



**Prof. Ashwin Vaidya (Math dept.)**



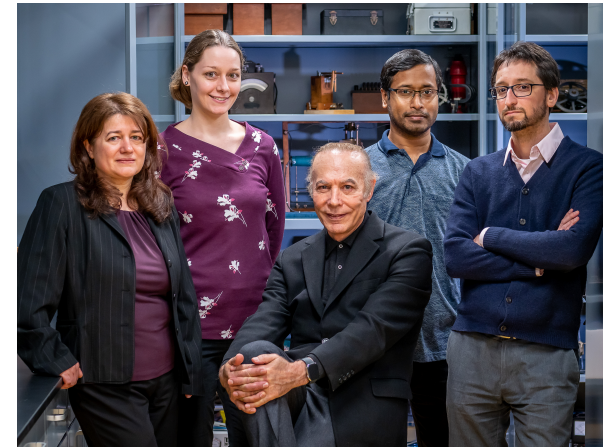
# Why Montclair State physics?

- Our department is a small, tight-knit community. Students know each other & the faculty. Small class sizes allow individual attention/mentoring.
- New curriculum provides excellent preparation for a range of STEM careers or graduate study.
- Newly renovated lab spaces teach atomic/nuclear physics, electromagnetism, optics, and more!
- Our faculty are known internationally, work on high-profile billion-dollar science projects, and have won multiple awards and grants. Excellence in research and teaching is our priority.
- Seminar courses and physics club expose you to state-of-the-art advances in physics, plus preparation for the physics major and post-graduation.
- Multiple degree paths provide options tailored to your career interests.
- Our students have a great track record of acceptance to graduate schools, landing top high school teaching positions, and corporate employment.



# Take-home message:

- Physics is awesome!
- Small classes, individual attention and mentoring—the physics faculty want you to succeed.
- Great career prospects (industry, grad school, teaching). A physics degree provides the skills sought out by a wide range of employers.
- Multiple degree options at Montclair State.  
But be prepared to work hard; we expect a lot from you.
- Get involved with our community: telescope nights, physics club, research opportunities/projects.
- We are here to help you—come talk to us!
- See our department website for more info:  
<https://www.montclair.edu/physics-astronomy/>





# Learn more about us:



## *Discussion session:*

- questions?
- talk to our students
- lab tours
- demos and flyers (CELS 1<sup>st</sup> floor)

## **Visit us on the web:**

<https://www.montclair.edu/physics-astronomy/>