Everyone should have a clicker

- Pick one up from the box at the top of the room.

- Please put it back on your way out 😊
When Stars **Attack!**
In Search of Killer Supernova Explosions

Speaker: Professor Brian D. Fields

**Date:** Saturday, October 25, 2014

**Time:** 10:15 a.m.

**Place:** 141 Loomis Laboratory

The most massive stars are the celebrities of the cosmos; they are very rare, but live extravagantly and die in a spectacular and violent supernova explosion. While these events are awesome to observe, they can take a more sinister shade when they occur closer to home, because an explosion inside a certain “minimum safe distance” would pose a grave threat to Earthlings.

We will discuss these cosmic insults to life, and ways to determine whether a supernova occurred nearby over the course of the Earth’s existence. We will then present recent evidence that a star exploded near the Earth about 3 million years ago.

Radioactive iron atoms have been found in ancient samples of deep-ocean material, and are likely to be debris from this explosion. These data, for the first time, allow sea sediments to be used as a telescope, probing the nuclear fires that power exploding stars. Furthermore, an explosion so close to Earth was probably a “near-miss,” which emitted intense and possibly harmful radiation.

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Saturday Physics for Everyone 2014
Physics Illinois
University of Illinois at Urbana-Champaign
Everyone Loves Science

10/11/14 Saturday Physics for Everyone
The U of I is a great place to teach
The mission of this university is:

- Research
- Teaching
- Public Engagement

Two facts to set the stage for this talk:
Physics at UIUC is BIG

Fall 2014
646 Physics Majors

Fall 2014
Intro classes
PHYS 100: 536
PHYS 110: 180
PHYS 101: 465
PHYS 102: 222
PHYS 211: 923
PHYS 212: 1186
PHYS 213: 600
PHYS 214: 603
Total: 4715

Intro Physics
Physics at UIUC is also very GOOD

<table>
<thead>
<tr>
<th>Rank</th>
<th>School</th>
<th>Tuition and Fees</th>
<th>Total enrollment</th>
<th>Fall 2012 acceptance rate</th>
<th>Average freshman retention rate</th>
<th>6-year graduation rate</th>
<th>Classes with fewer than 20 students</th>
<th>SAT/ACT 25th-75th percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>University of Illinois—Urbana-Champaign</td>
<td>in-state: $15,258, out-of-state: $29,540</td>
<td>44,520</td>
<td>63.3%</td>
<td>94%</td>
<td>64%</td>
<td>[🔒]</td>
<td>[🔒]</td>
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<tr>
<td>#2</td>
<td>Cornell University</td>
<td>$45,359</td>
<td>21,424</td>
<td>16.6%</td>
<td>96%</td>
<td>93%</td>
<td>[🔒]</td>
<td>[🔒]</td>
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<tr>
<td>#3</td>
<td>Massachusetts Institute of Technology</td>
<td>$43,498</td>
<td>11,189</td>
<td>9.0%</td>
<td>97%</td>
<td>93%</td>
<td>[🔒]</td>
<td>[🔒]</td>
</tr>
<tr>
<td>#3</td>
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<td>6.6%</td>
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<td>[🔒]</td>
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<tr>
<td>#3</td>
<td>University of California—Berkeley</td>
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<td>97%</td>
<td>91%</td>
<td>[🔒]</td>
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<tr>
<td>#6</td>
<td>California Institute of Technology</td>
<td>$41,538</td>
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<tr>
<td>#7</td>
<td>Harvard University</td>
<td>$42,292</td>
<td>19,726</td>
<td>6.1%</td>
<td>98%</td>
<td>97%</td>
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<tr>
<td>#8</td>
<td>University of Michigan—Ann Arbor</td>
<td>in-state: $13,819, out-of-state: $40,496</td>
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<td>96%</td>
<td>91%</td>
<td>[🔒]</td>
<td>[🔒]</td>
</tr>
</tbody>
</table>
Clicker Question:

Please tell me about your last Physics class

A. I have never taken a physics class
B. I took physics in high school
C. I took intro physics in college
D. I took advanced physics in college
E. I took physics in grad school
Clicker Question:

What do you remember most from your high school or college intro physics class?

A. How the equations were derived
B. The experiments and demonstrations
C. Talking to the other kids in class

Moral: Boring = Bad
A demo you will remember

The orange balloon contains hydrogen. The red balloon contains hydrogen + oxygen.

Which one will make the loudest explosion when I put a match to it?

A. Orange (all \( \text{H}_2 \))
B. Red (half & half \( \text{H}_2 \) & \( \text{O}_2 \))
That’s was **not** boring!

**Problem:** I can’t blow stuff up every time I want you to remember something.
Things that we know help us learn
(besides explosions)

• Thinking about stuff before class

• Talking about stuff in class

• Practicing & exploring stuff outside class
Illinois inventions that help all three
Thinking about stuff before class
Clicker Question:

In high school or college, how much time did you spend reading your physics text-book before each class? Please be honest.

A. I didn’t read it much
B. Less than 10 minutes
C. 10-30 minutes
D. 30-60 minutes
E. More than 60 minutes
We asked our students the same question:

How often do you read the text before attending class?

- Algebra-based physics (N = 669)
- Calculus-based physics (N = 632)
Student are smart and they prioritize...

Books not optimized to convey difficult abstract concepts

Multimedia works better
We developed *Prelectures* and use these instead of a text-book:
Show
(Unit 2 Superposition)
We also ask students to answer a few questions before they come to class:
Preparing our students this way allows us to:

1) Prepare lectures better
2) Use lecture time better

This is sometimes called “Flipping the Classroom”
A physics **demo** launches one marble horizontally while at the same instant dropping a second marble straight down. Which one hits the ground first?

A) The launched marble hits first.
B) The dropped marble hits first.
C) They both hit at the same time.
You are trying to shoot a dart containing flea repellant at a monkey hanging from a branch in a distant tree.

You point the gun directly at the monkey.

At the same instant that you pull the trigger, the itchy monkey lets go of the branch and starts to fall.
Predict: Will the dart hit the monkey?

A) Yes, even though the monkey is falling
B) No, the dart misses, passing **below** the monkey
C) No, the dart misses, passing **above** the monkey
Still works even if you shoot upwards!

Dart hits the monkey
Talking about stuff in class
(we just did this)

We needed a way for students to participate in class, for credit, without feeling self-conscious...
...so we built one ourselves
...so we built one ourselves
You are the first people to ever use these in a real lecture.

This one is actually completely new & different (2.4GHz, new RF protocol,...)
So let's try to break it:

One the count of 3: *Everyone click A once*

Please pay attention to the LED next to the A button. It will flash **RED** or **GREEN**
In the test you just did, what color did the LED flash?

A. RED
B. GREEN
How does all this impact our students?
Changes Made Learning Easier!

Course Difficulty

- Fall 01
- Fall 02
- Fall 03
- Fall 04
- Fall 05
- Fall 06
- Fall 07
- Fall 08
Student Perception of Course

- Difficult Course
- Positive Attitude
- Lecture Valuable

Before

After
Practicing & exploring stuff outside class

Interactive Online Laboratories
It all started innocently enough...
Include other sensors...

Version 0
Version 2

Magnetometer

Accelerometer

Gyroscope

Expansion Connectors

- 6 x Analog in
- 1 x DAC out
- 6 x Digital I/O/PWM
- Hi-Gain Amp
- FTDI Header
  
  \(V_{bat}, V_{3.3}, \text{gnd}\)

Wheel Encoder

\((y, v_y, a_y)\)

Force Probe \((\pm F_y)\)

Microphone

Buzzer

Light Intensity

Temperature

Atmospheric Pressure

It can be built for less than $50

Demo
Pilot Studies

Several universities involved:
UIUC, Millikin, UNC, Umass Amherst, Portland, UT Austin,

Several High Schools also involved:
Mahomet-Seymour HS, Wilmington HS

- Softball swing video
- Dog acceleration video
- Car acceleration video
- High Heel video
Serendipity: Cheap ECG machine

• About a hundred young athletes suffer Sudden Cardiac Death each year in the US.

• Several common causes can be found with an ECG screening.

• High cost and inconvenience barriers to widespread screening.

SO:

• Let’s simplify screening
It works great in clinical study.
Working with Med School & DIA
The mission of this university is: Research, Teaching, Public Engagement

Physics Van
Clicker Question:

Have you seen a Physics Van show?

A. No
B. Yes – I saw it in elementary school
C. Yes – I saw it when I was older
D. Yes – I was a volunteer putting on the show
E. More than one of the above
• Traveling science show run by undergraduates.
  – Target area elementary schools (~100 mile radius).
  – Other venues not that unusual...
    • Illinois State Fair, Scouts, Home Schools, etc...
    • Spring Break: Colorado, New Mexico, Florida (twice)
Recruit Volunteers
Pack the Van with goodies.

Drive to the school
Meet the kids
Everyone Has Fun

Students

• We have done nearly 700 shows since 1994:
  – Seen by about 100,000 kids, 14,000 adults!
Dear Physics Van students,

Thanks so much for coming to share your enthusiasm and talents today at the Joy in Learning Homeschool Academy. We appreciated your presentation, and I especially enjoyed that your love for physics was evident during your show. What an inspiration to all our budding scientists! Thanks again for sharing today, and helping to nurture future physicists. Your work makes a difference, and I appreciate you all!

Most sincerely,
Dee Chapman
The Volunteers love it too!

INTERSESION  MARCH 18
APRIL 5

IT'S OKAY TO MAKE MISTAKES. THAT'S THE WAY WE LEARN.

CHILDREN'S SCIENCE MUSEUM

MULBERRY SCHOOL
Impact on graduate volunteers:

– Took me a while to realize that this is most important.

We had our 20th reunion on March/2014.

– Physics Van alumni came from all over the US.
Important Lesson:
Liquid Nitrogen is cool!
Everyone Loves Science

That’s what makes it so interesting to teach!

Teaching science is, in itself, a science.