




ANGELS & DEMONS™  
*Lecture Night*  
THE SCIENCE REVEALED

Kevin Pitts  
University of Illinois  
28-Jul-2009

 ILLINOIS



 Fermilab



U.S. DEPARTMENT OF  
**ENERGY**



National Science  
Foundation

# ANGELS & DEMONS™

## Lecture Night

THE SCIENCE REVEALED

### Disclaimer

- This is Elizabeth Clement's talk
- Big effort from:
  - Fermilab Communications office
    - **Elizabeth Clement, Katie Yurkewicz**
  - Fermilab UEC, US LHC Users Organization



## WHY OUTREACH?

1. The U.S. is largely a scientifically illiterate nation.
  - **Misperceptions about the nature of science**
  - **Misperceptions about the role of science**
  - **Misperceptions about scientists**
2. Funding for basic research comes from the government, we need to tell them what they are getting for their investment.
3. Young people choose career paths based upon what they are exposed to. No exposure to STEM (science, technology, engineering and mathematics) fields, no scientists and engineers in the next generation.

## WHY OUTREACH?

**Creationism, that is, the idea that God created human beings pretty much in their present form at one time within the last 10,000 years is: [Gallup June 2007]**

<b>Definitely true</b>	<b>probably true</b>	<b>probably false</b>	<b>definitely false</b>	<b>no opinion</b>
39%	27%	16%	15%	3%

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## WHY OUTREACH?

"It's said that, according to the law of aeronautics and the wingspan and circumference of the bumblebee, it is aeronautically impossible for the bumblebee to fly. However, the bumblebee, being unaware of these scientific facts, goes ahead and flies anyway."

• Mike Huckabee, ABC's "This Week", Dec 2, 2007.

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## WHY OUTREACH?

We need to make young people “aware” of science. If they are aware of what we do and what science is, the interest will take care of itself.



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## WHY OUTREACH?

“American pre-eminence in STEM will not be secured or extended without concerted effort and investment. Trends in K-12 and higher education in science and math preparation, coupled with demographic and labor supply trends, point to a serious challenge: our nation needs to increase the supply and quality of “knowledge workers” whose specialized skills enable them to work productively within the STEM industries and occupations....Our nation’s economic future depends upon improving the pipeline into the STEM fields...”

-The STEM Workforce Challenge  
U.S. Department of Labor

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## A GOLDEN OPPORTUNITY

- Antimatter
  - CERN
  - Religion
  - Murder
  - Sex
  - Tom Hanks and  
Ron Howard
- HELLO HOLLYWOOD!





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## RESOURCES FOR LECTURERS

- Web site
- Template poster
- Template talk
- Images and videos
- General tips

(Password protected)



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## MATTER VS. ANTIMATTER

Anti-Tom Hanks



Would look  
very much  
like

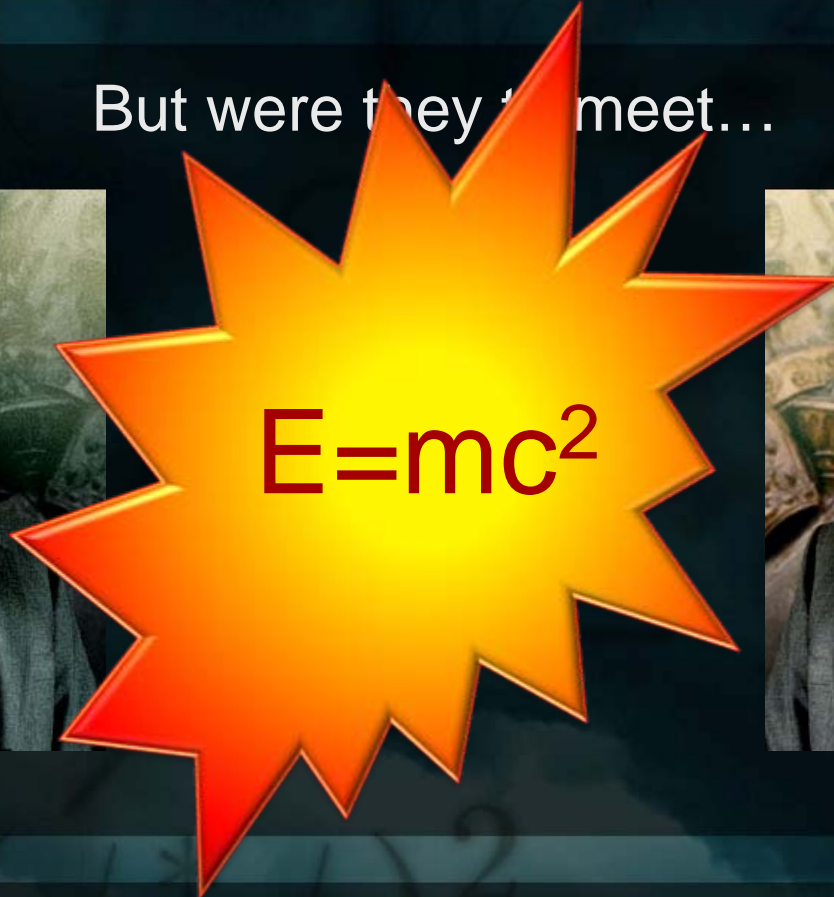
Tom Hanks



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MATTER VS. ANTIMATTER

But were they to meet...



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## Fermilab Communications Office

- National press release
- Served as press contacts
- Worked with Sony Pictures
- Images and videos for media
- Links to other resources
- “In the News” archive



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## THE LECTURES

**Total lectures: 61**

- **United States – 44**
- **Canada - 8**
- **France – 4**
- **Germany – 2**
- **Spain – 1**
- **Switzerland - 2**
- **Total reported attendance: 4,628**
- **Total attendance >5,000 !!!**



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## VIRTUAL LECTURES

Missed the lecture?

Catch one online  
instead!



[http://www.uslhc.us/Angels\\_Demons/schedule-videos.html](http://www.uslhc.us/Angels_Demons/schedule-videos.html)

# ANGELS & DEMONS™

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### Our U of Illinois Experience

- Advertising is more important than the talk itself
- Issued a press release and followed up with local media.
- TV interview, radio interview, newspaper article followed
- Made lots of posters and hung them all over town, including at the movie theaters.



## UI physicists to discuss science in "Angels & Demons"

Thursday May 28, 2009

URBANA – Around the world, big screens show Tom Hanks trying to save the Vatican from antimatter that, if exposed, will destruct with enough force to vaporize a chunk of Rome.

Well, that's the fiction of "Angels & Demons" anyway.

Around the country, physicists like the University of Illinois' Kevin Pitts and Mark Neubauer – scientists who work with facilities that produce the real antimatter – will be hosting dozens of public talks about the real physics behind the movie magic.

"The movie touches on the kind of science that we do – which doesn't happen very often," Pitts said.

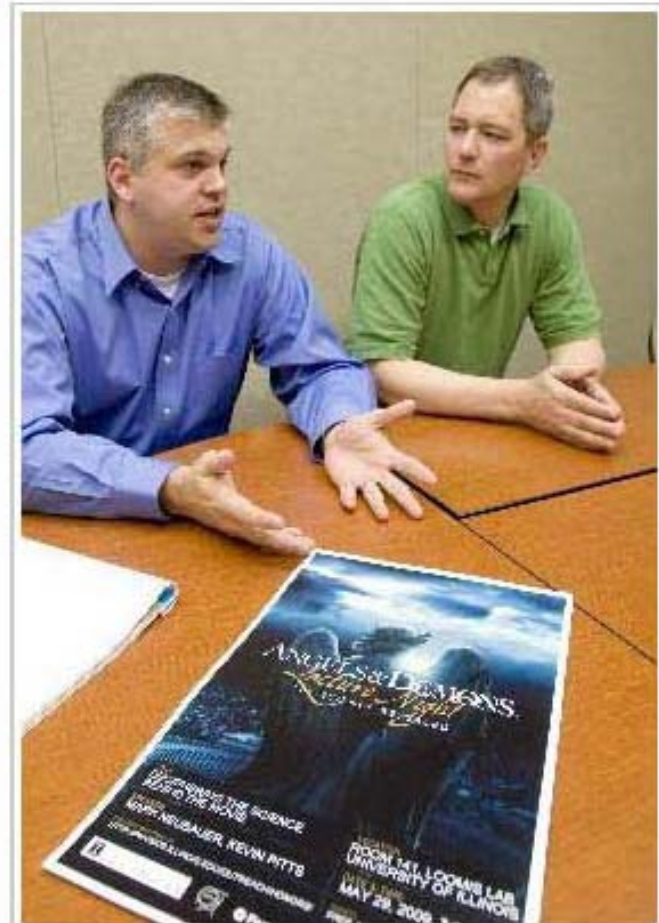
"We think that it's an opportunity to clarify," said Neubauer, who was at CERN, the Geneva lab that's an "Angels & Demons" plot point, when Tom Hanks visited for the movie.

Both will be clarifying on Friday, when they'll welcome anyone – kids included – to a free 7 p.m. lecture "Deciphering the Science Behind the Movie" in Loomis Lab on northeast corner of Goodwin Avenue and Green Street in Urbana on the UI campus.

"Antimatter is real, we really do produce it," Pitts said.

That happens at places like CERN or Fermilab in northern Illinois, where scientists do collide matter together at speeds a "tiny, tiny fraction lower than the speed of light," Neubauer said. "We focus energy to create different kinds of matter."

That collision creates "like a spray of lots of different kind of particles," he said.



Robert K. O'Daniell

Mark Neubauer, left, and Kevin Pitts talk about their lecture on the real science of antimatter, as featured in the new movie "Angels & Demons," at Loomis Lab on the University of Illinois campus.





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## Lecture Night

- We served cookies and soft drinks.
- We put together a “program” that had some background info and “FAQ” about what we were going to talk about.
  - Folks said they liked looking at it and reading through it prior to the lecture.
- We spent time doing “meet and greet” out in the lobby prior to the lecture.
  - It helped to promote a warm, welcoming environment!

## What are the benefits of high energy physics research?

The primary goal of high energy physics research is to obtain knowledge about how the universe works. But the technology and innovation required to carry out this research has led to a number of benefits to society. For example, technology developed by high energy physicists are routinely used in cancer treatment (radiation therapy), medical imaging (PET, MRI), as well as the semiconductor and computing industries. The World Wide Web was invented at CERN. High energy physics also trains students in areas of science, engineering and technology.



Particle accelerators are used for proton radiation therapy for cancer treatment. particle

## Who funds high energy physics research?

In the United States, high energy physics is supported by the federal government through the U.S. Department of Energy and the National Science Foundation. Funding basic science research and development is an important investment in the future competitiveness of our nation.

**Professor Mark Neubauer** earned his Ph.D. in high energy physics at the University of Pennsylvania. After research positions at Massachusetts Institute of Technology and the University of California at San Diego, Mark joined the faculty at the University of Illinois in 2007. Mark works on the CDF experiment at Fermilab and the ATLAS experiment at the CERN Large Hadron Collider.




Mark Neubauer

**Professor Kevin Pitts** earned his Ph.D. in high energy physics at the University of Oregon. After a research position at Fermi National Accelerator Laboratory, Kevin joined the faculty at the University of Illinois in 1999. Kevin works on the CDF experiment at Fermilab.



Kevin Pitts



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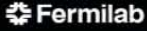


**Deciphering the Science Behind the Movie**

**Mark Neubauer, Kevin Pitts**

**141 Loomis Lab**  
**University of Illinois**

**May 29, 2009, 7:00pm**

[HTTP://PHYSICS.ILLINOIS.EDU/OUTREACH/HONORS/](http://physics.illinois.edu/outreach/honors/)

**I ILLINOIS**    

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Welcome to the Department of Physics at the University of Illinois and thank you for attending *Angels & Demons: the Science Revealed*.

Whether or not you've read the book or seen the movie, we hope to make this evening's lecture fun and interesting. Please feel free to ask questions at any time before, during or after the presentation.

### What is high energy physics?

High energy physics, also known as elementary particle physics, is the study of nature at its most fundamental level. The goal of high energy physics is to understand the very basic building blocks of matter, and the forces govern the behavior of those particles. The subatomic particles that we study are far too small to be seen with even the most powerful microscopes, these particles are as small compared to a single atom as a human hair is to the University of Illinois campus!



Fermilab accelerator complex in Batavia, Illinois

### How are high energy physics experiments performed?

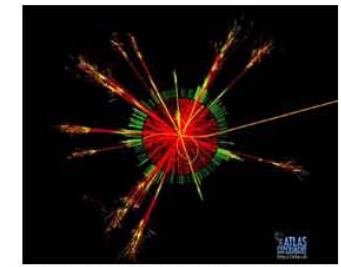
To study nature at tiny distances, high energy physicists need very large particle accelerators. The particle accelerator at Fermilab in northern Illinois is four miles in circumference. Protons circle the accelerator 50,000 times every second! These high energy particles smash into one another, briefly reproducing conditions that have not occurred naturally since a fraction of a second after the Big Bang. The CERN Large Hadron Collider in Geneva, Switzerland is the highest energy particle accelerator ever constructed.



The ATLAS Detector at the CERN Large Hadron Collider

### What is antimatter?

Our universe, including Earth and its inhabitants are comprised of matter. Protons, neutrons and electrons are all elements of matter, and they combine form elements such as hydrogen, helium, carbon and oxygen. Each form of matter (such as a proton) has a corresponding form of antimatter. The antimatter counterpart to a proton is an antiproton. The proton has positive electric charge and the antiproton has a negative electric charge. The proton and antiproton have exactly the same mass. Protons are abundant, but our universe has almost no antiprotons.



A simulated high energy collision at the LHC

### If antimatter doesn't exist naturally, how is it produced?

Albert Einstein derived the famous equation  $E=mc^2$ , which tells us that energy can be converted into matter and matter can be converted into energy. In particle accelerator, we give particles tremendous amounts of energy by accelerating them up to incredibly high speeds. When these particles collide with other particles, the particle energy can be converted in to new particles, some of which are antimatter.



Students working electronics for the CDF detector.

### How much antimatter can we make?

Accelerators have been making very tiny amounts of antimatter for over 50 years now. It would take us about 100 million years to produce  $\frac{1}{4}$  gram of antimatter. Tiny amounts of antimatter are used in positron emission tomography (PET) scans.

### What happens when matter and antimatter come into contact?

When matter and antimatter come together they annihilate and convert their mass into energy. Annihilation means that the original particles cease to exist. Reactions of this type have been observed and studied by high energy physicists for years.

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## Our Lecture

- We had 190 people in attendance.
- Two things surprised me:
  - Less than half the audience had seen the movie or read the book.
  - Questions from the audience were fast and furious.
- Timing:
  - We cut off the lecture at 90 minutes, although people were still asking questions.
  - We took questions down front for another 60 minutes before the crowd finally left.
- It was extremely fun, very rewarding and we got lots of positive feedback.

## Other opportunities

- Folks like to hear about science, BUT
  - They need to be convinced that it will be accessible.
  - They don't need the \*entire\* story.
  - It needs to be a modest time investment and entertaining.
- We try to achieve this with our Saturday Physics program.
  - We are careful about who we recruit ask to talk.
  - We advertise extensively.
  - We emphasize the audience to the speakers.

Department of Physics  
University of Illinois at Urbana-Champaign  
Room 141 Loomis Laboratory of Physics  
1110 W. Green Street, Urbana, IL 61801

▶ Saturday Honors Physics Program is an outreach program for high school students and the general public.

▶ All lectures are free and begin at 10:15 am. Parking is available on the east side of Loomis Lab in lot B21.

2008

## Saturday Physics Honors Program

**September 27**    **How We Use Light to Illuminate Biology**  
UIUC Professor Bob Clegg

**October 11**     **The Pervasive Nature of Feedback in Natural and Engineered Systems**  
UIUC Professor Andrew Alleyne

**October 25**    **Physics Day**  
UIUC Professor Mats Selen

**November 8**    **Transforming Science, Policy, and the Power Grid with High Temperature Superconductivity**  
UIUC Professor Laura Greene

**November 22**   **The Physics of UFO's**  
UIUC Professor Kevin Pitts

**December 6**    **Law and Science**  
UIUC Professor Amy Gajda

<http://physics.illinois.edu/outreach/honors>  
For more information contact: Toni Pitts 217.244.2948 or [tpitts@illinois.edu](mailto:tpitts@illinois.edu)



**Dave Hertzog and the physics of music**



**Matthias Grosse-Perdekamp smashing pumpkins to emulate RHIC collisions**

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## Final Thoughts

- We need to continue to look for other opportunities
- It would be good to find ways to expand these types of lectures to beyond the standard “university community”
  - Why not take the Angels and Demons lectures on the road?



A large, dark, monochromatic image of a statue. On the left, a woman's head and shoulders are visible, looking upwards. On the right, a figure in a long, dark, hooded robe stands with their back to the viewer, looking towards the woman. The background is a dark, atmospheric landscape with a cityscape visible in the distance under a cloudy sky.


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THANK YOU  
For more information

[http://www.uslhc.us/Angels\\_Demons/index.html](http://www.uslhc.us/Angels_Demons/index.html)

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