

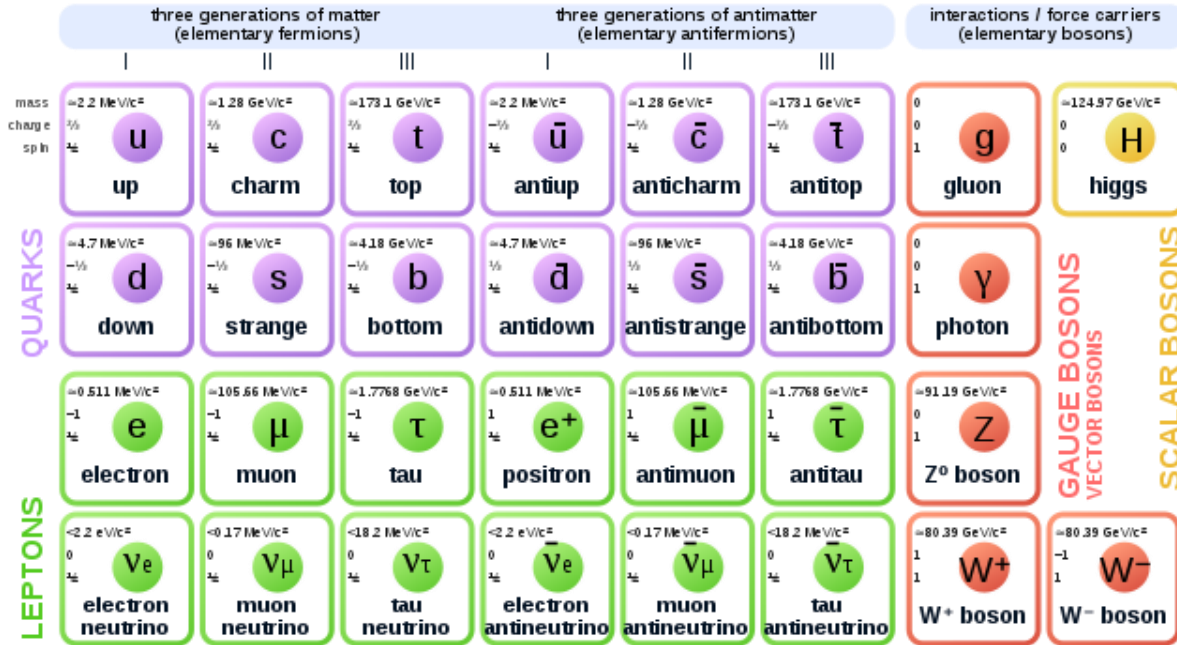
# Antimatter Research

Antimatter Research



# Curriculum & Classroom Connections

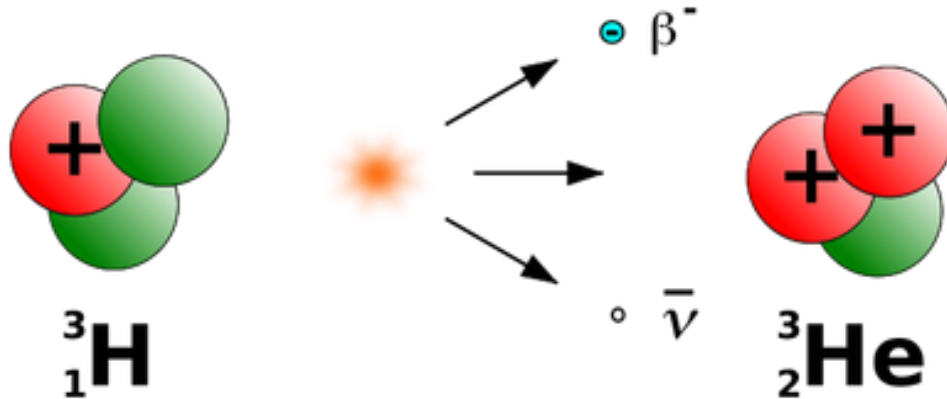
## Standard Model of Elementary Particles



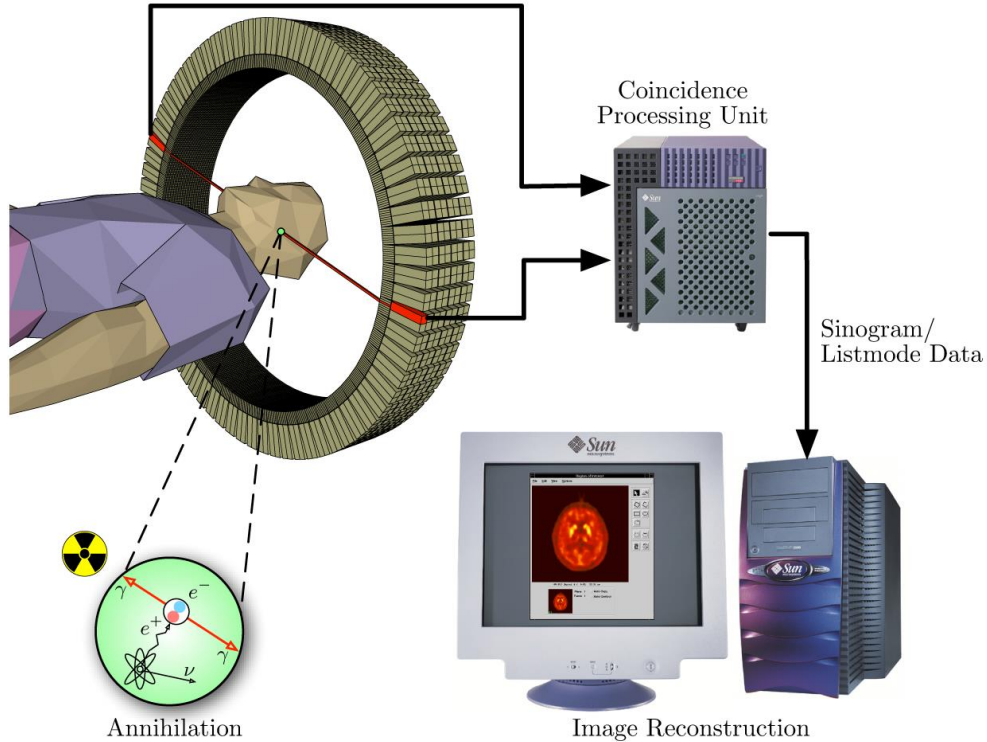
- Standard model: particle “twins”

# Curriculum & Classroom Connections

- Nuclear physics:  $\beta$  decay

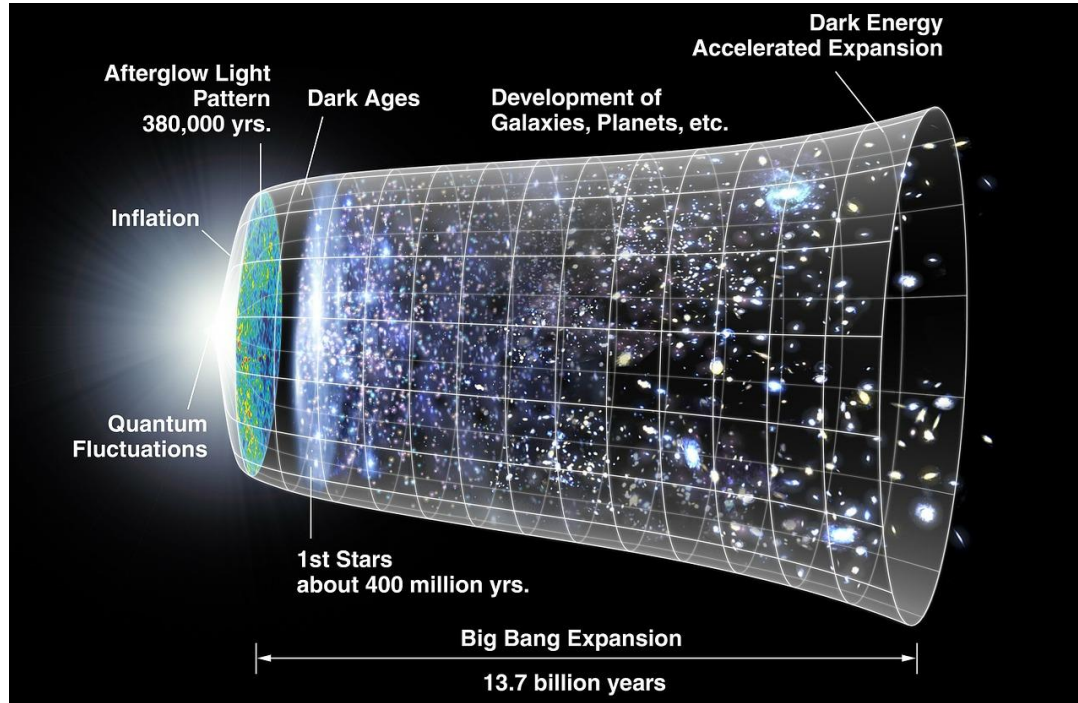


# Curriculum & Classroom Connections



- Medical applications: PET scan

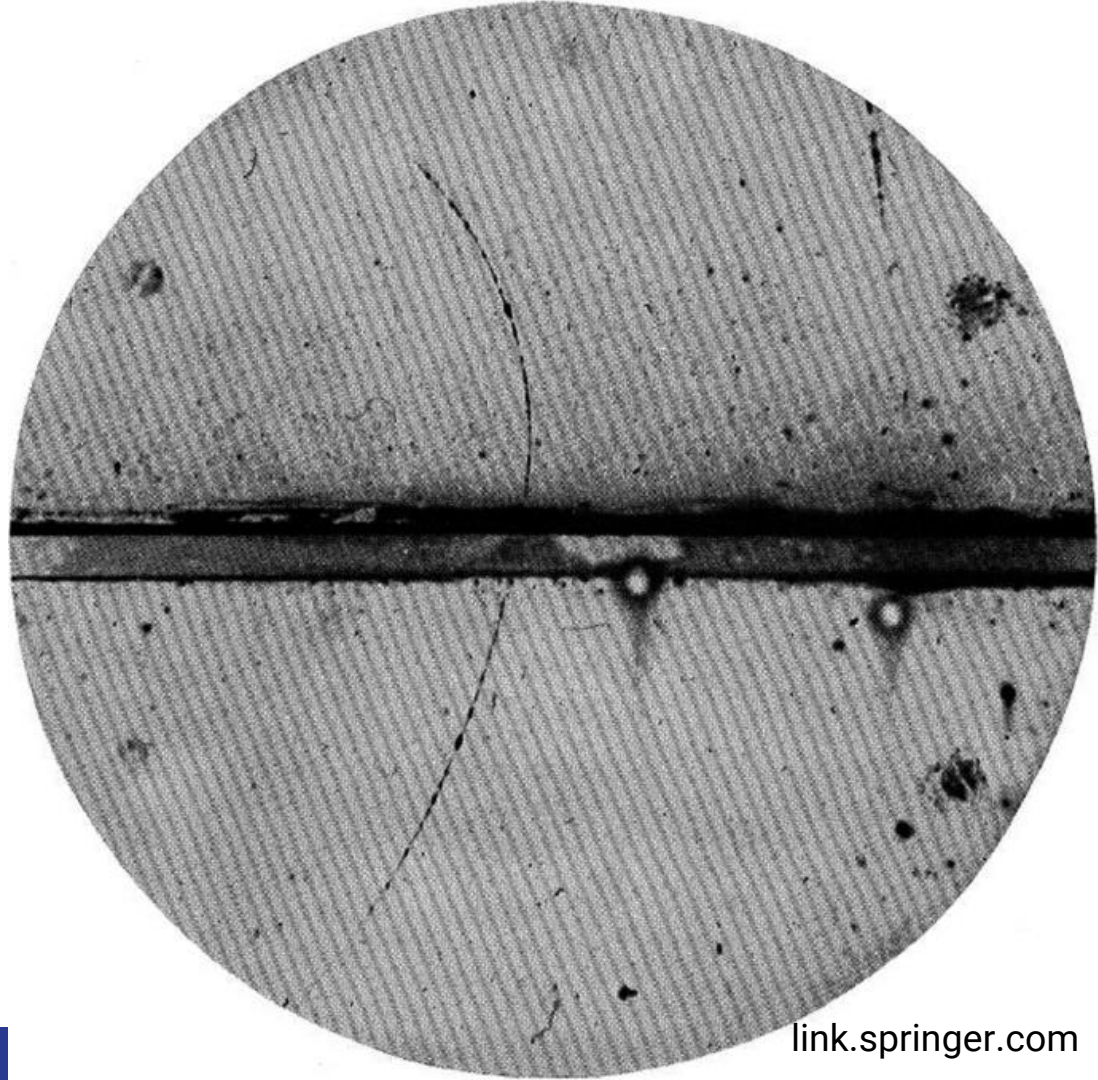
# Curriculum & Classroom Connections



- Big Bang Theory: asymmetry between matter and antimatter - still an open question!

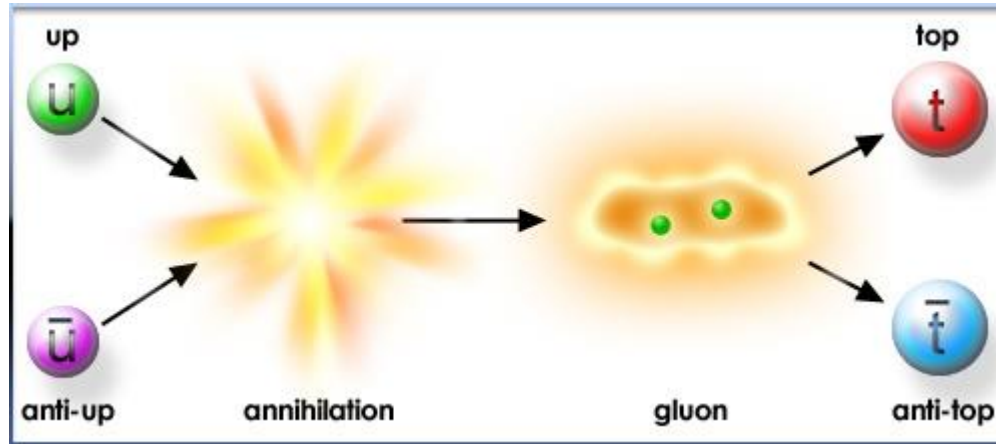
# Key Ideas

- Carl Anderson detected a positron in a cloud chamber, proving the existence of antimatter.



# Key Ideas

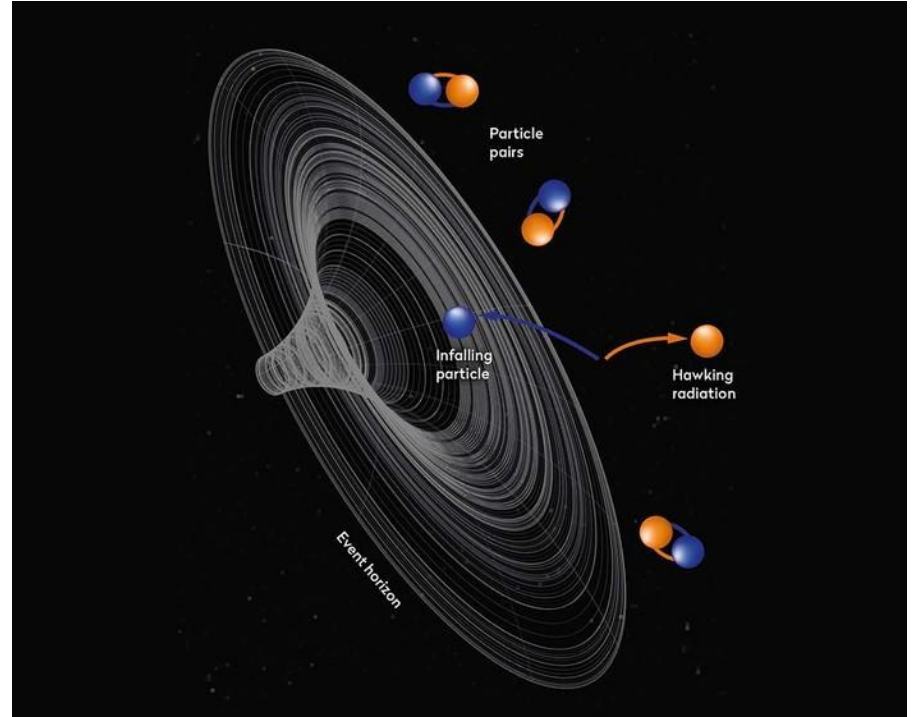
- Annihilation (canceling out) and pair production



particleadventure.org

# Key Ideas

- Hawking Radiation

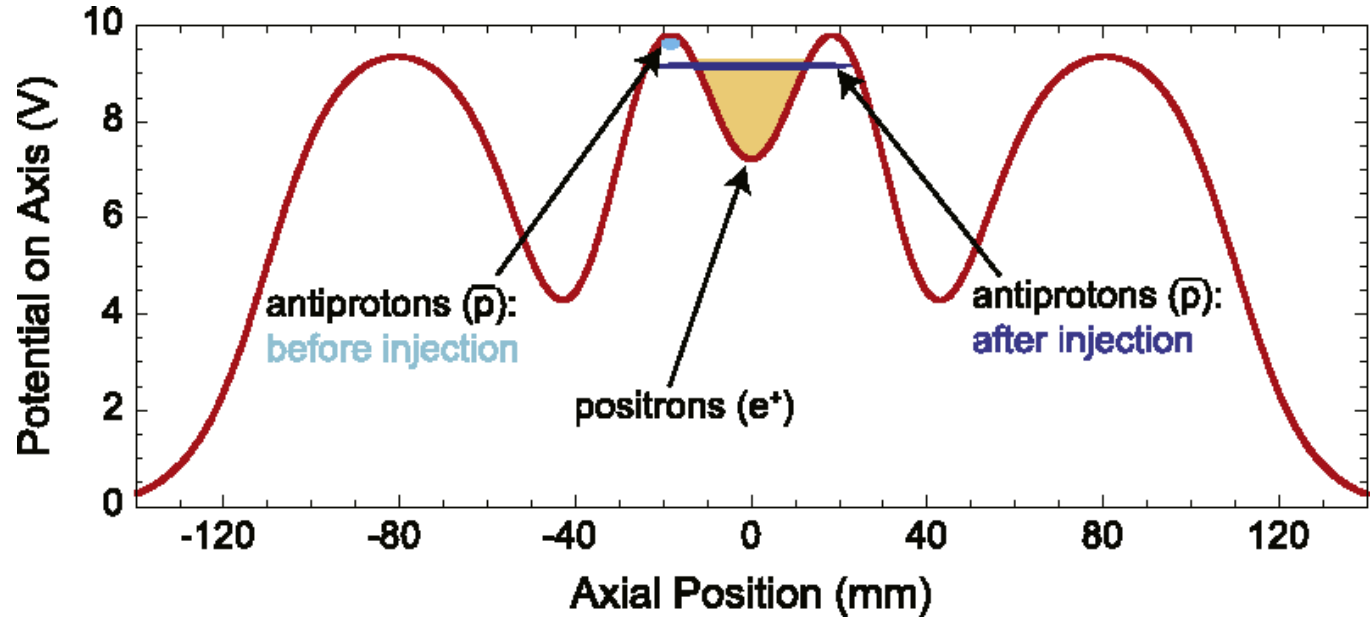


[skyatnightmagazine.com](http://skyatnightmagazine.com)



# Key Ideas

- Trapping antimatter
- Potential wells



# Key Ideas

- We don't know!
- Be mindful of language used - models



# What are some conceptions students may have?

Anyone want to share an idea you think a student of yours might have about antimatter? Or what question(s) will the word antimatter bring up?



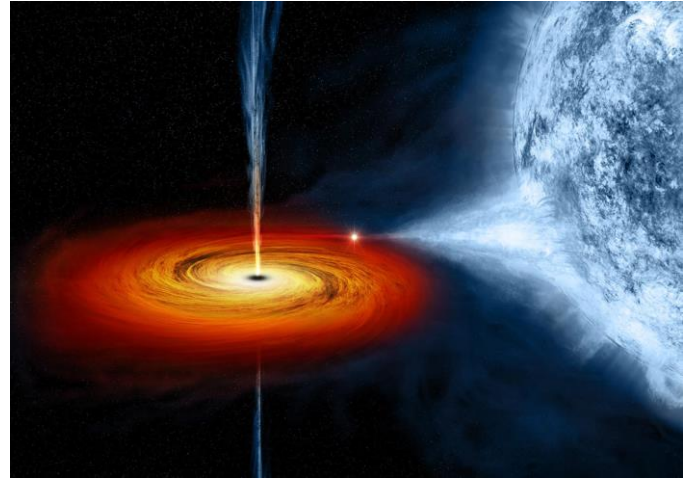
# Potential students' conceptions & challenges

- Is the particle and antiparticle the same?? Mass?? Charge? Spin?
- Aren't they in 50/50? If so how can I be sitting here? Is there an antimatter version of me sitting in another dimension?
- Is it like in the movie angels and demons? Can you carry it in a suitcase around town?



[rudoz012.tumblr.com/post/183141910905/embed](https://rudoz012.tumblr.com/post/183141910905/embed)

# Potential students' conceptions & challenges



[encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcQ-J0\\_YMP1srV6XdqPWpcjBkTtRPagENeek2fnnZULK-wVmb&s](https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcQ-J0_YMP1srV6XdqPWpcjBkTtRPagENeek2fnnZULK-wVmb&s)

- What's the difference between dark matter and antimatter... aren't they the same thing?
- Do black holes eat antimatter?
- What happens if antimatter touches dark matter?
- Are there certain conditions required for annihilation?

# Potential students' conceptions & challenges

- What about wave functions of particles? Do antiparticles have the opposite wave function?
- Why are we so sure antimatter has to exist?
- If I time travel back in time how does that link to matter? Antimatter? Is antimatter from the future? Isn't that what Feynman diagrams show us?



# Helpful Material and Resources



[Antimatter factory 360° view](#)

[Hands on antihydrogen simulation](#)

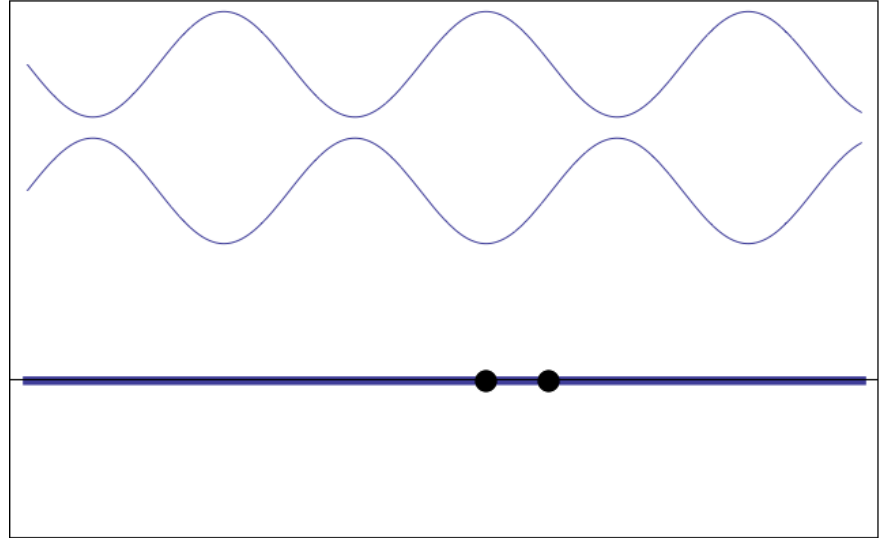
[Antimatter Rap](#)

[Angels and Demons Q&A](#)



# Best Practice Examples

- Annihilation Models
  - Opposite numbers
  - Forces with action/reaction
  - Viruses and antidotes
  - Neutralization reactions
  - Conservation Laws
  - Noise canceling headphones

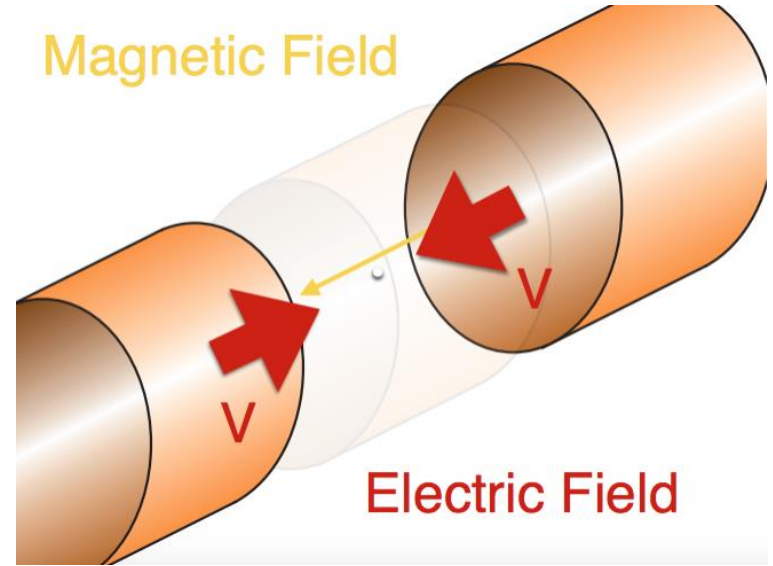


<http://www.acs.psu.edu/drussell/Demos/superposition/standing.gif>



# Best Practice Examples

- Lesson Ideas
  - Acting out reactions
  - Unit Conversion Calculations
    - Banana Calculations
  - Storage
    - Magnetic Fields
    - Charged Plates



[https://indico.cern.ch/event/932906/contributions/4890303/attachments/2479886/4256862/20220713\\_What%20s%20the%20Matter%20with%20Antimatter.pdf](https://indico.cern.ch/event/932906/contributions/4890303/attachments/2479886/4256862/20220713_What%20s%20the%20Matter%20with%20Antimatter.pdf)

# Thank you and questions?



<https://i.pinimg.com/originals/1b/a4/82/1ba482431937d80524715439dfb88ef9.gif>

Ari  
Ashley  
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