

The Large Hadron Collider

At Discovery's Horizon

Ian Shipsey

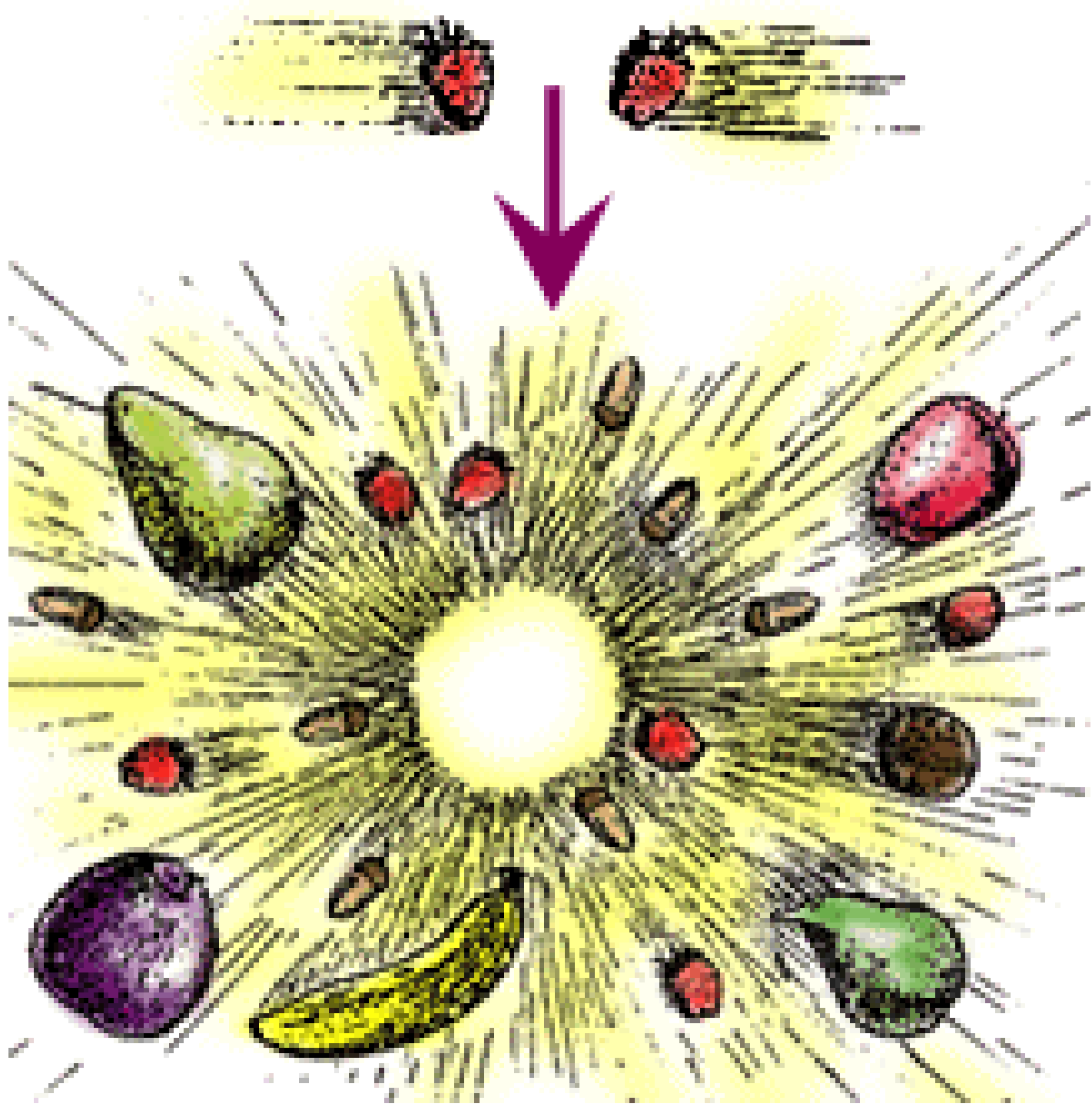
Purdue & Fermilab

Large Hadron Collider Physics Center at

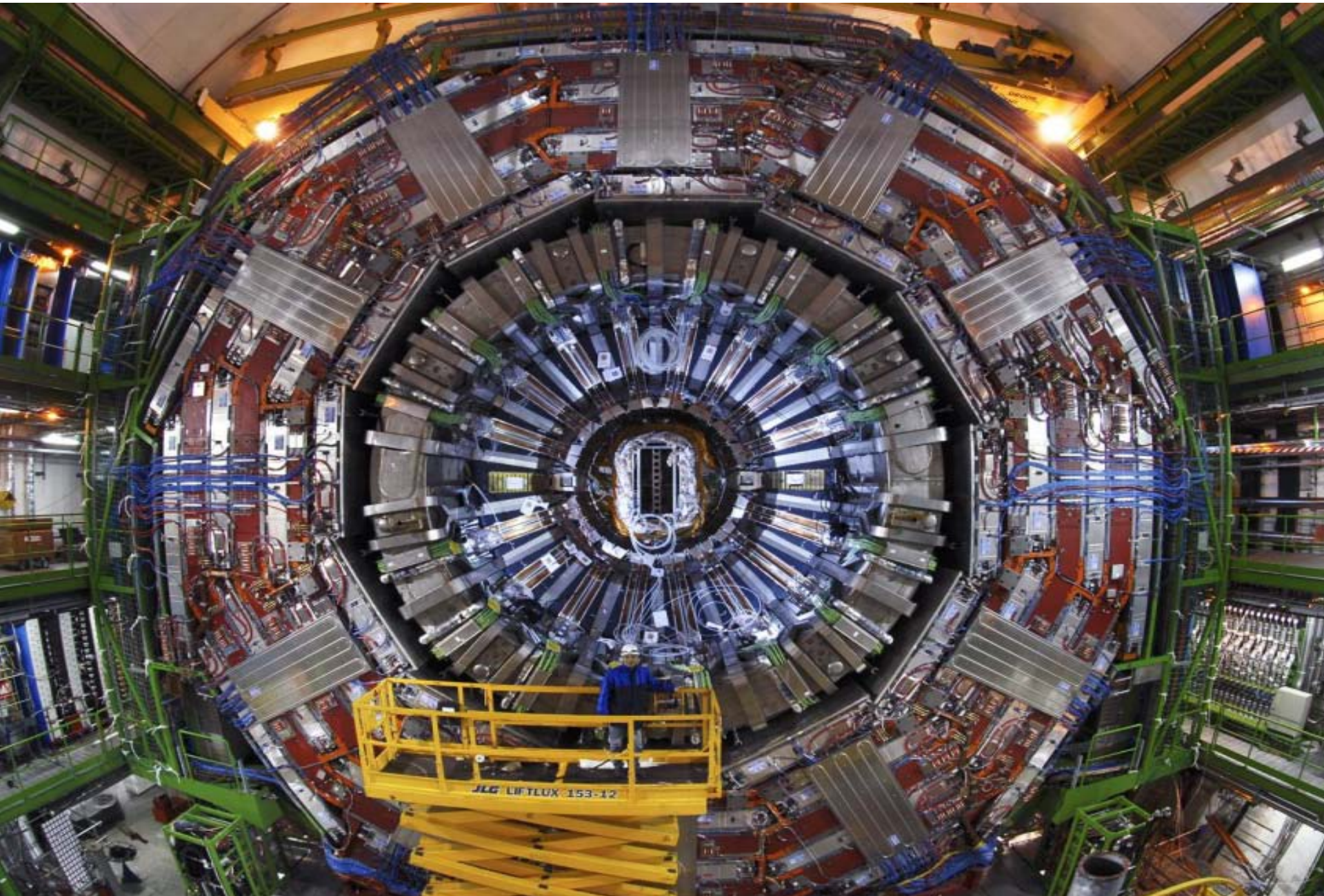
Fermilab co-Coordinator

Introduction to CMS at the LHC

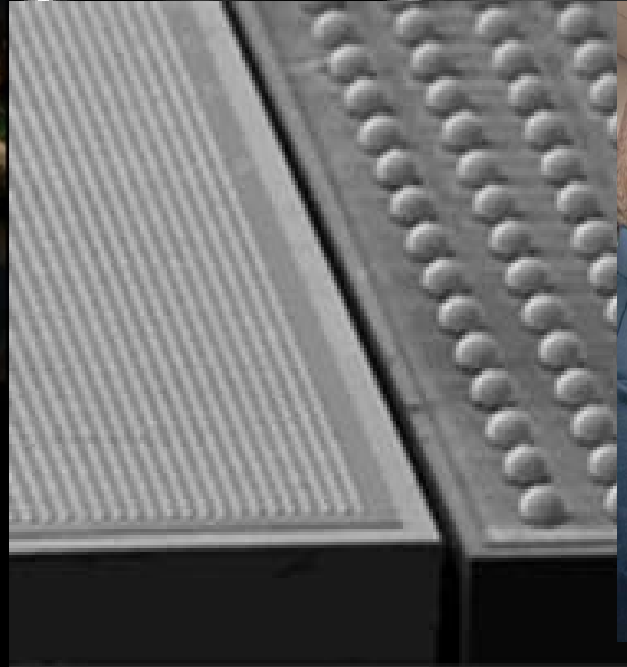
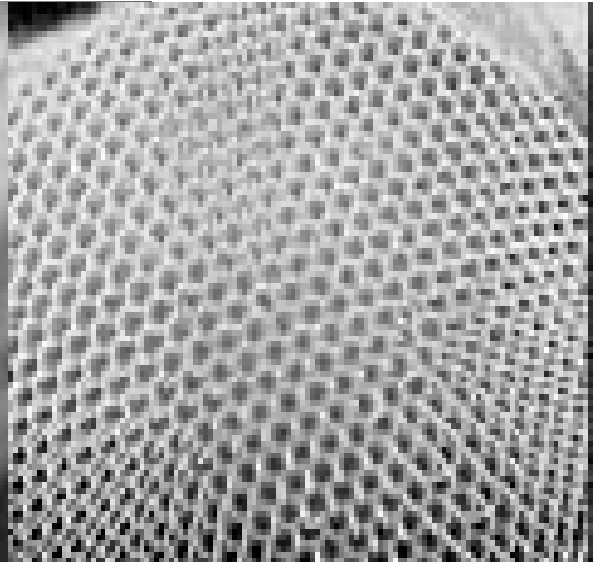
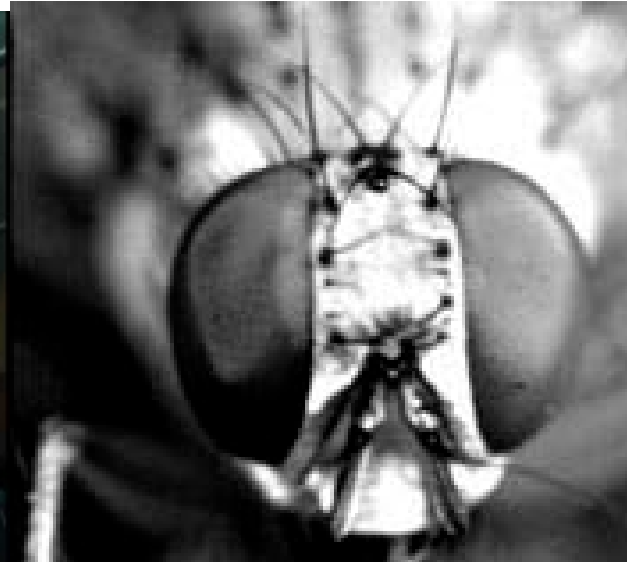




A CATHEDRAL-SIZED CAMERA

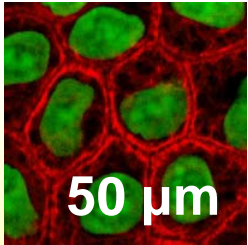


AS INTRICATE AS THE EYE OF A FLY



Built at FNAL
in collaboration
with 14 US universities

The building blocks of matter



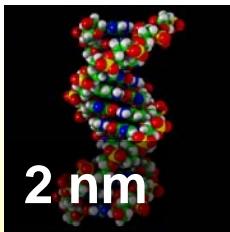
Extra magnification?

CELLS

Twenty per mm



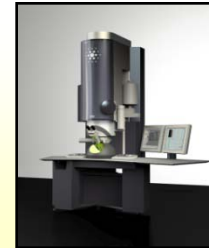
Microscope



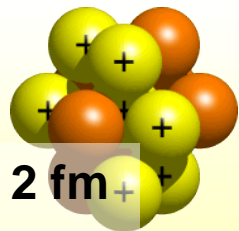
x 25 thousand

DNA

Five hundred thousand per mm



Electron microscope

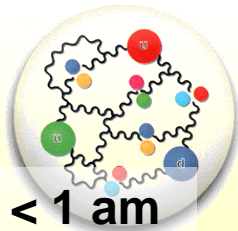


x 1 million

Nucleus

Five hundred billion per mm

Particle Accelerators



x 2 thousand

Quarks

More than one million billion per mm

BUILDING A UNIVERSE



proton



neutron

Multiply by billions and billions and billions

BUILDING A UNIVERSE

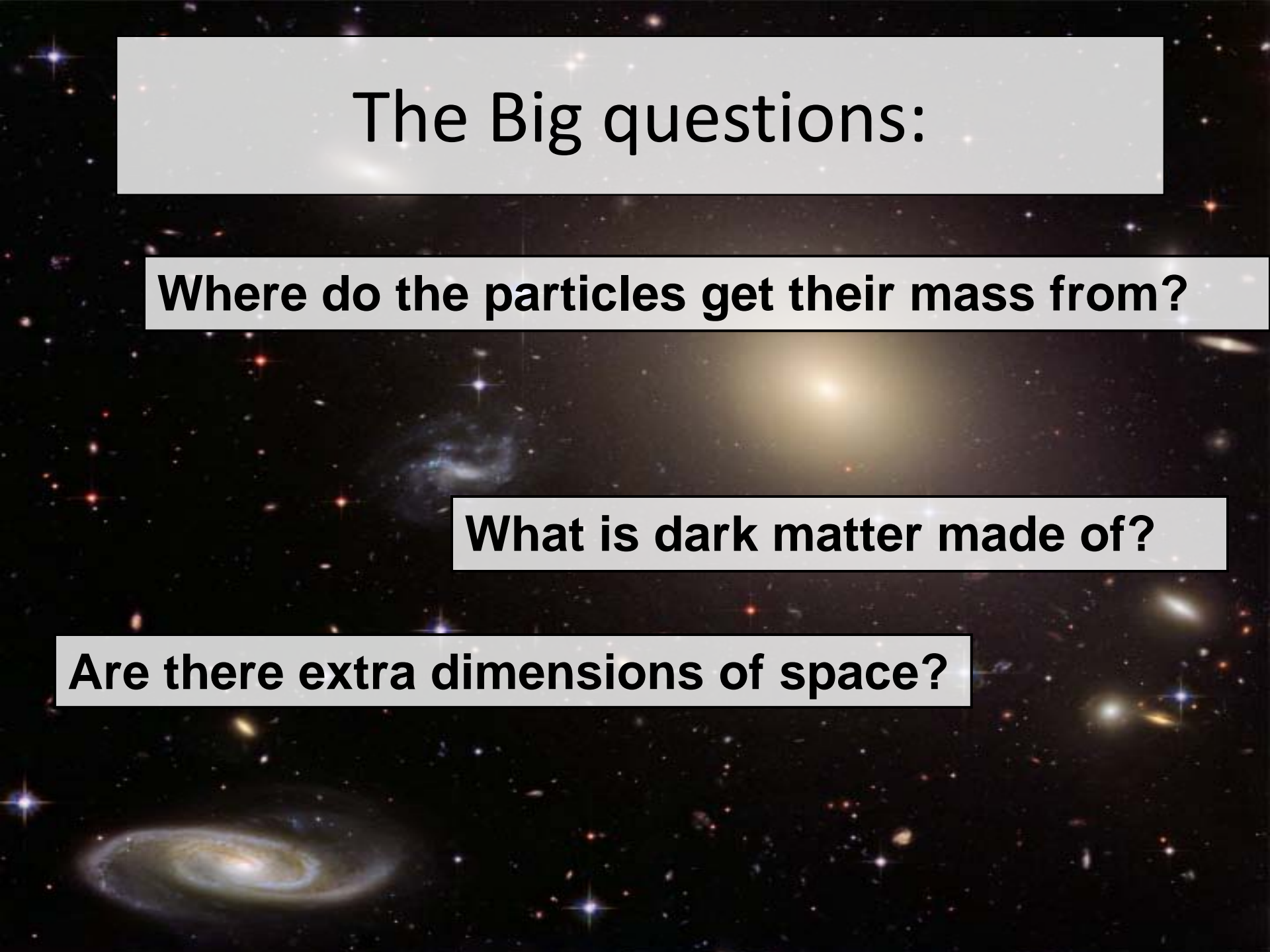


The Big questions:

Where do the particles get their mass from?

What is dark matter made of?

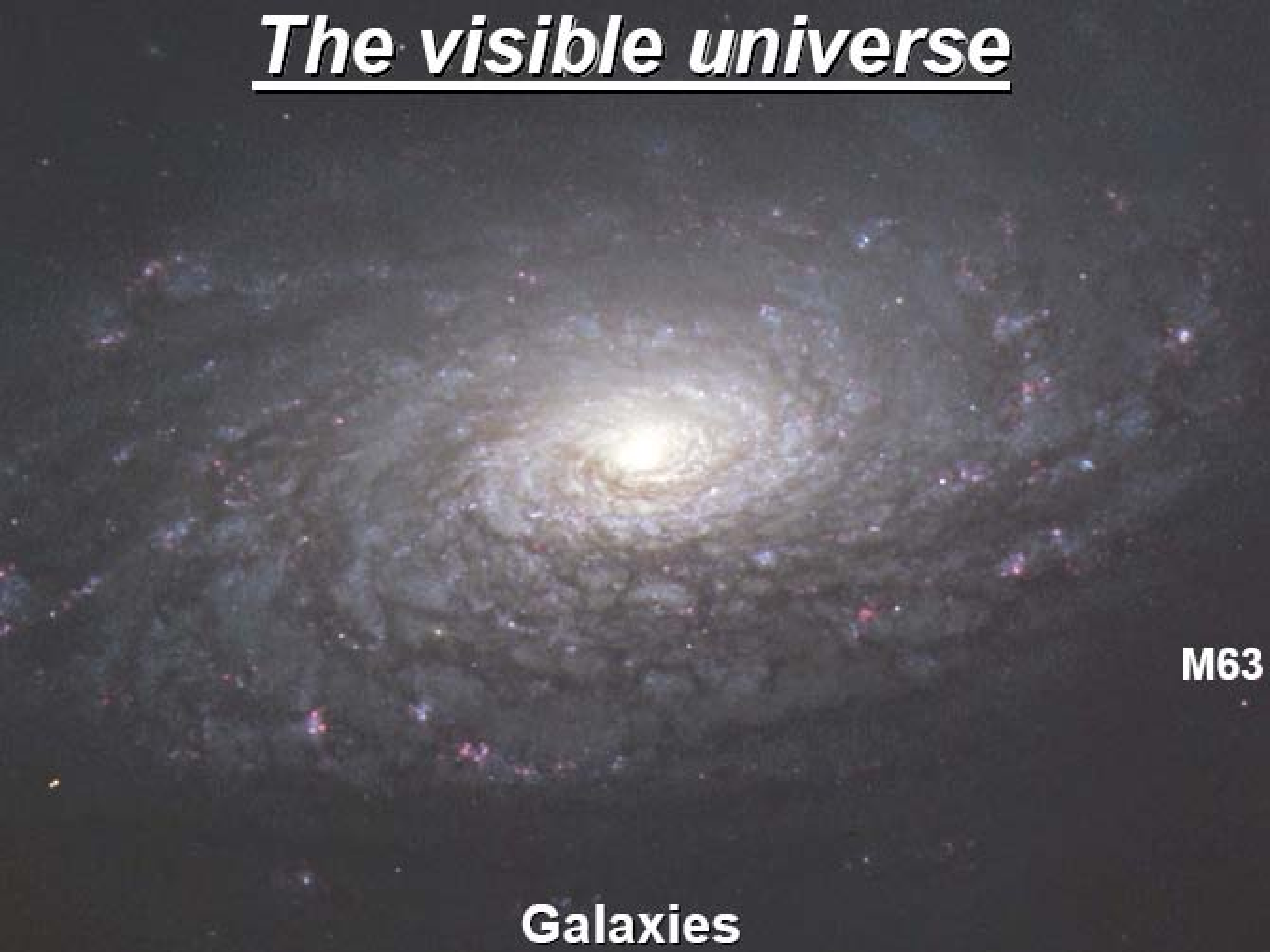
Are there extra dimensions of space?



Where do the particles get their mass from?



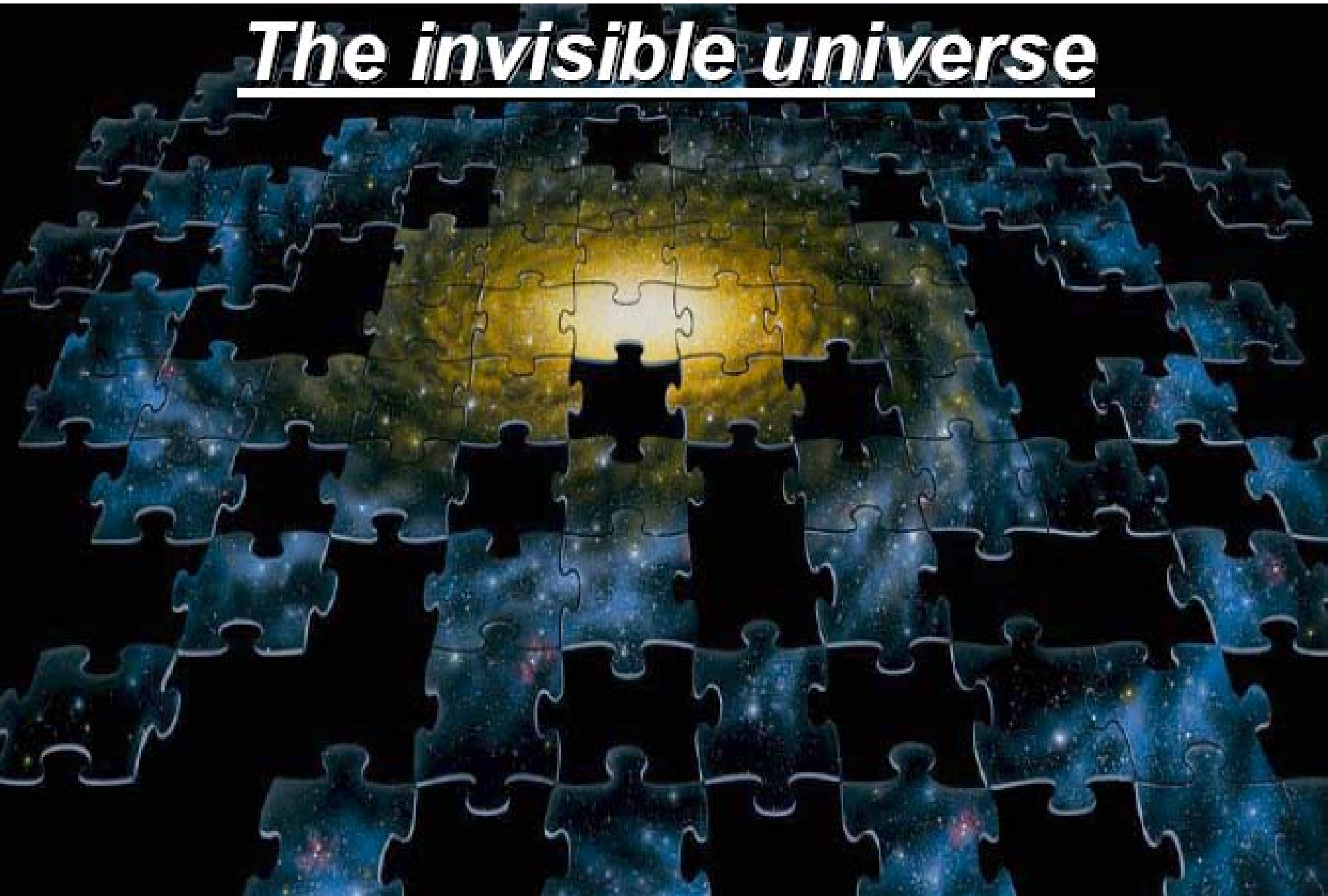
The visible universe



M63

Galaxies

The invisible universe



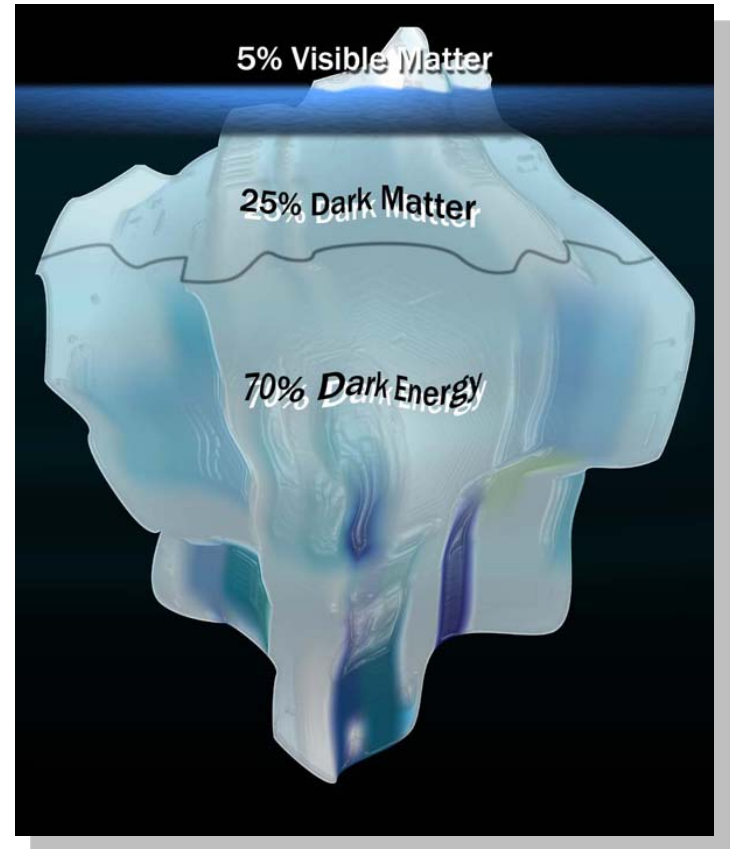
Dark Matter (5 times more than visible matter)

What is Dark Matter?

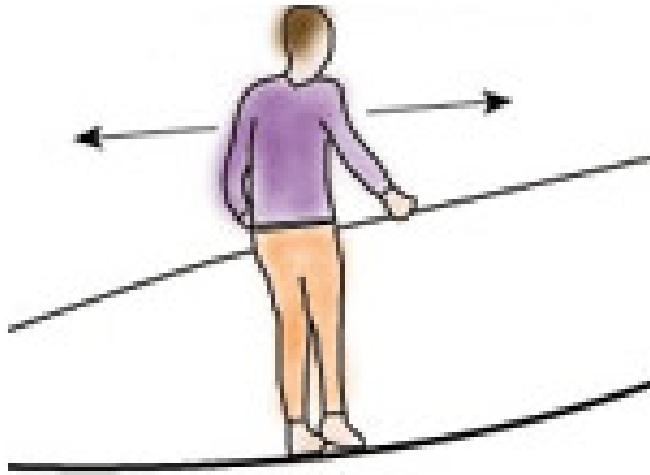
Normal matter: Made from atoms
(i.e quarks and electrons)
Includes stars,
planets, people...

Dark matter: Unknown substance
(not atoms)

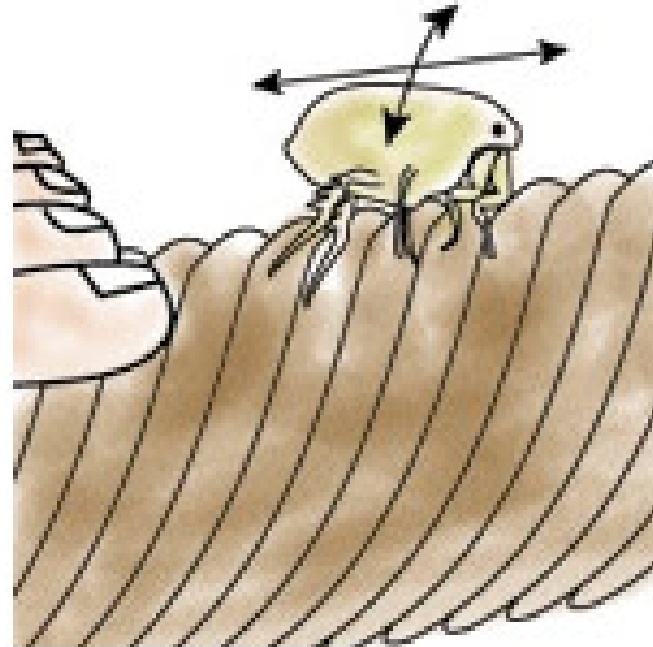
Dark energy: Even weirder!



Are there extra dimensions of space?



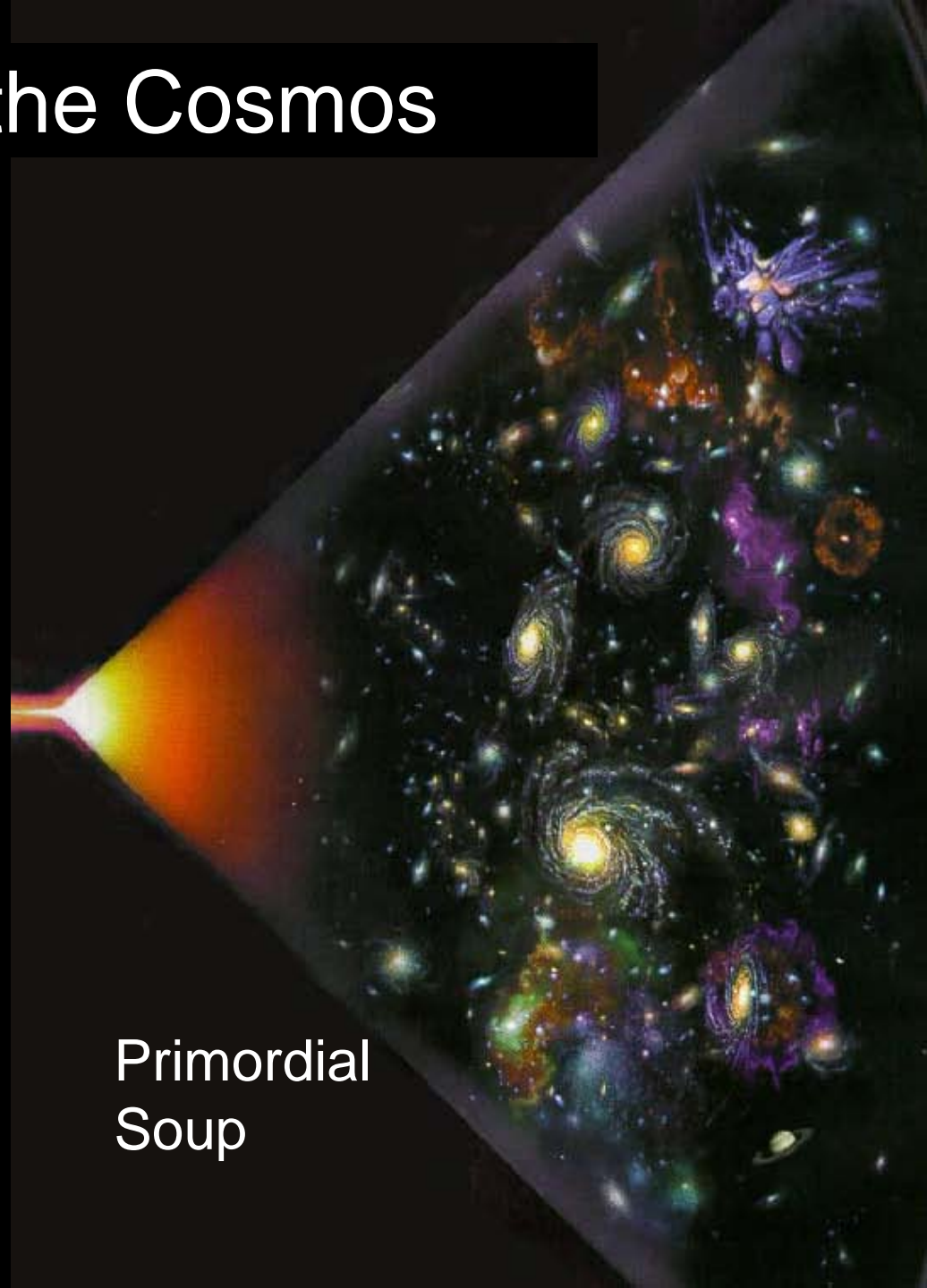
An acrobat can only move in one dimension along a rope..



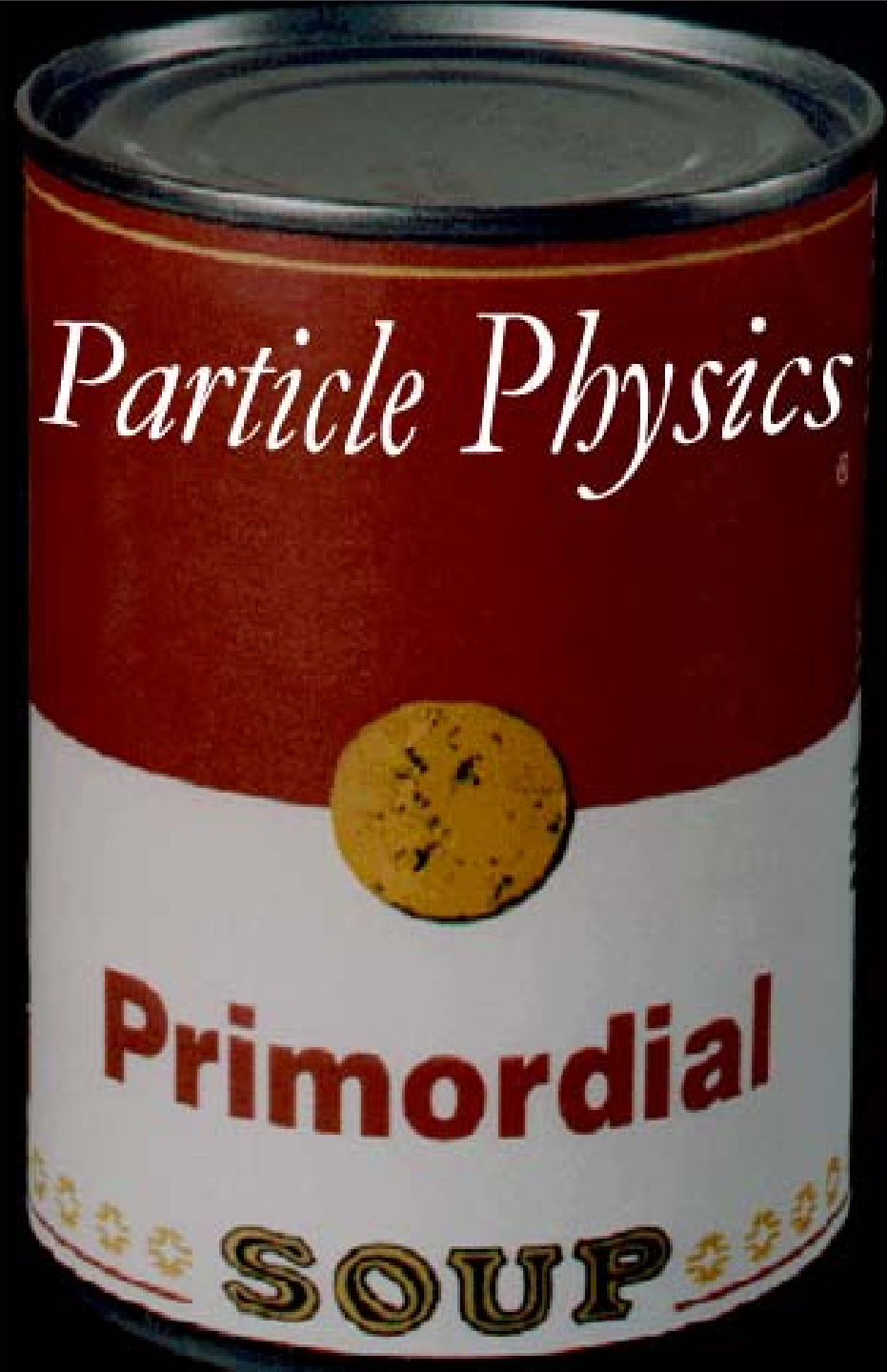
...but a flea can move in two dimensions.

An atom in the rope moves in three dimensions. Who is to say that as we get to smaller and smaller distances the direction we can move in i.e. the number of dimension do not continue to increase?

Quarks to the Cosmos



Primordial
Soup



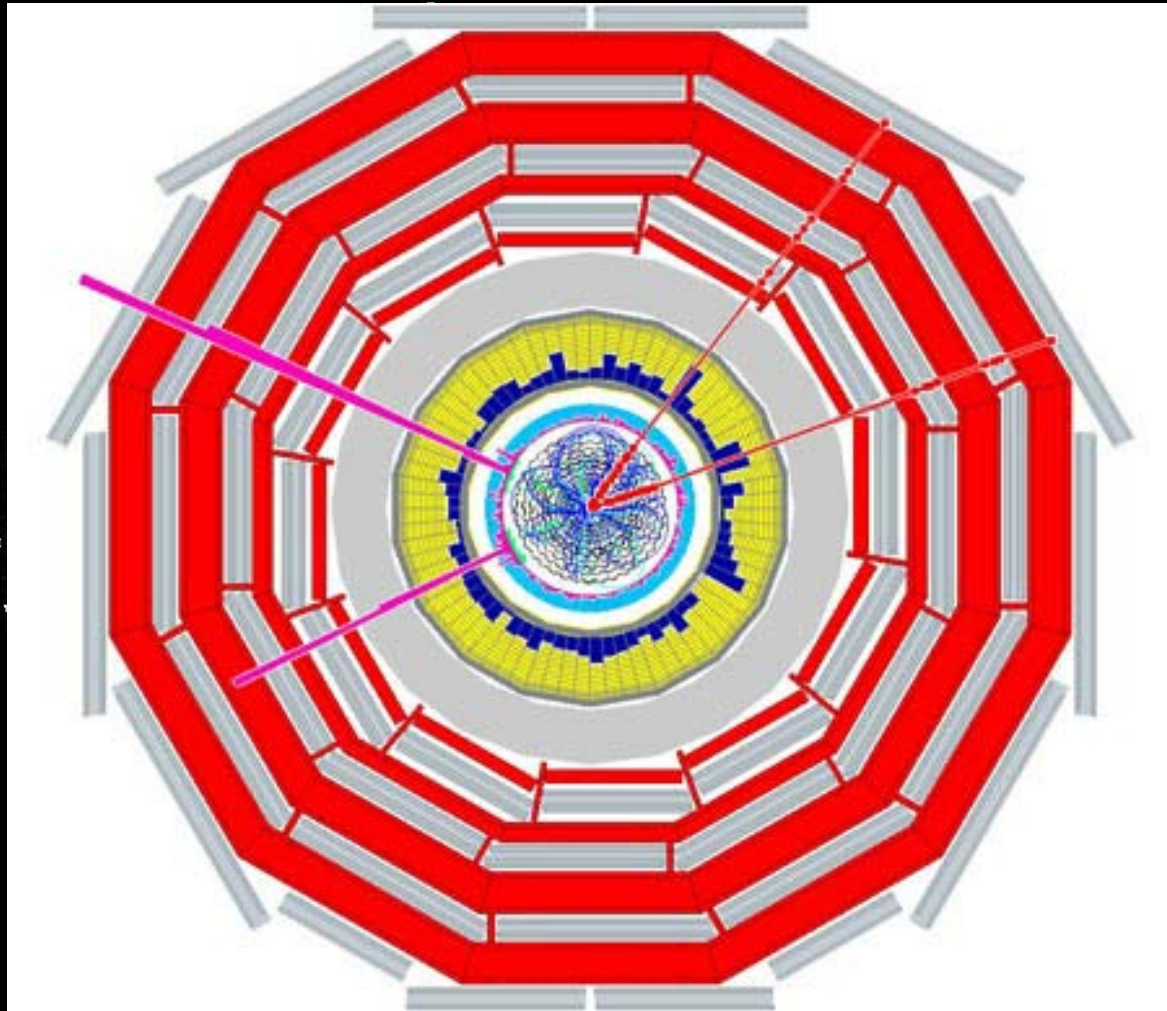
Particle Physics



Primordial

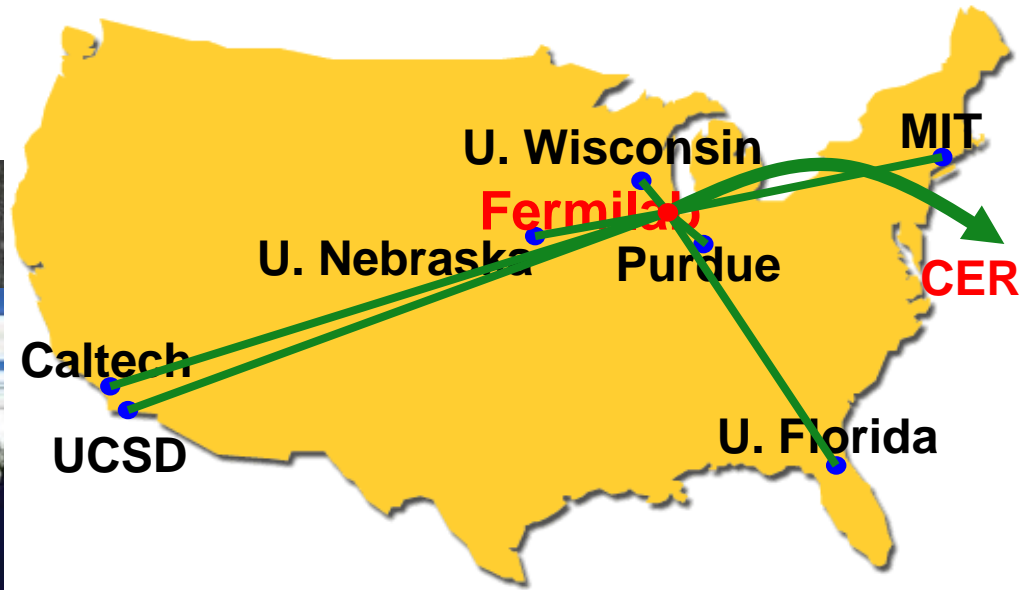
SOUP

Simulated Higgs Particle



.....15 million CDs, 15 petabytes per year, a stack of CD 10 miles high (X1.5 mount Everest)

Data Analysis



MonALISA
View Discovery Groups Position Security Help
Normal view On Top view 0 186.52
3D Map Reset Actions Zoom Rotate Scale modes
Browse
Graph
Table
GMap
Topology
Load
WAN
C.JOB

To analyze the LHC data is an enormous task – beyond the means of CERN alone
Need to send these data to the computers and storage systems of the collaborating institutes around the world – in real time, without stopping!
This is the World Wide GRID
Why not offer YOUR computer at <http://lhathome.cern.ch/> ?!

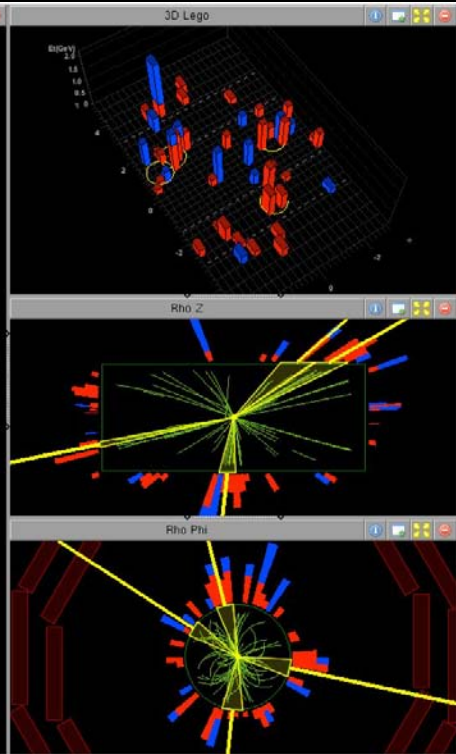
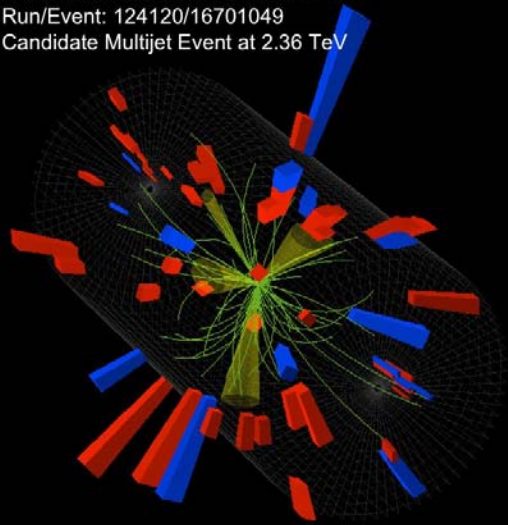


During one second of CMS running, a data volume equivalent to 10,000 Encyclopaedia Britannicas is recorded





CMS Experiment at the LHC, CERN
Date Recorded: 2009-12-14 05:41 CET
Run/Event: 124120/16701049
Candidate Multijet Event at 2.36 TeV



FIRST COLLISION
DATA END 2009

FIRST RESULTS
FROM COLLISION
DATA SUBMITTED
FOR PUBLICATION
FEB 2010

LHC PHYSICS
CENTER
AT FERMILAB
(US, OVERSEAS
& FNAL
POPULATION)



Particle Physics Spin-offs



Medical Imaging



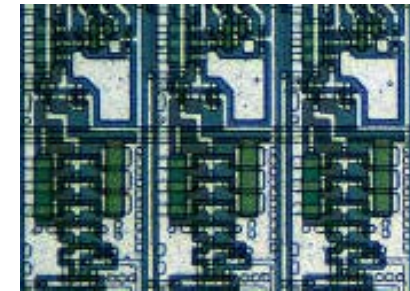
Bright X rays source
Materials/chemistry/biology



Education



Computing
WWW



Silicon based Technology

IMPACT OF SCIENTIFIC RESEARCH

“No one can predict what new applications will be born of basic research: new treatments in our hospitals; new sources of efficient energy; new building materials; new kinds of crops more resistant to heat and drought.

It was basic research in the photoelectric effect that would one day lead to solar panels. It was basic research in physics that would eventually produce the CAT scan. The calculations of today's GPS satellites are based on the equations that Einstein put to paper more than a century ago....”

-- President Barack Obama,
Speech to National Academy of Sciences, April 27, 2009

An aerial photograph of a large body of water, possibly a lake or a wide river, with a red circular line overlaid on it. The water is a deep blue color, and the surrounding land is a mix of green and brown. The red line is a thick, curved stroke that forms a large arc across the middle of the image.

LHC DATA TAKING RECOMMENCING

**LIKE GALILEO POINTING HIS TELESCOPE
TO THE SKY FOR THE FIRST TIME IN 1608**

WE'LL BE HAPPY TO KEEP YOU POSTED