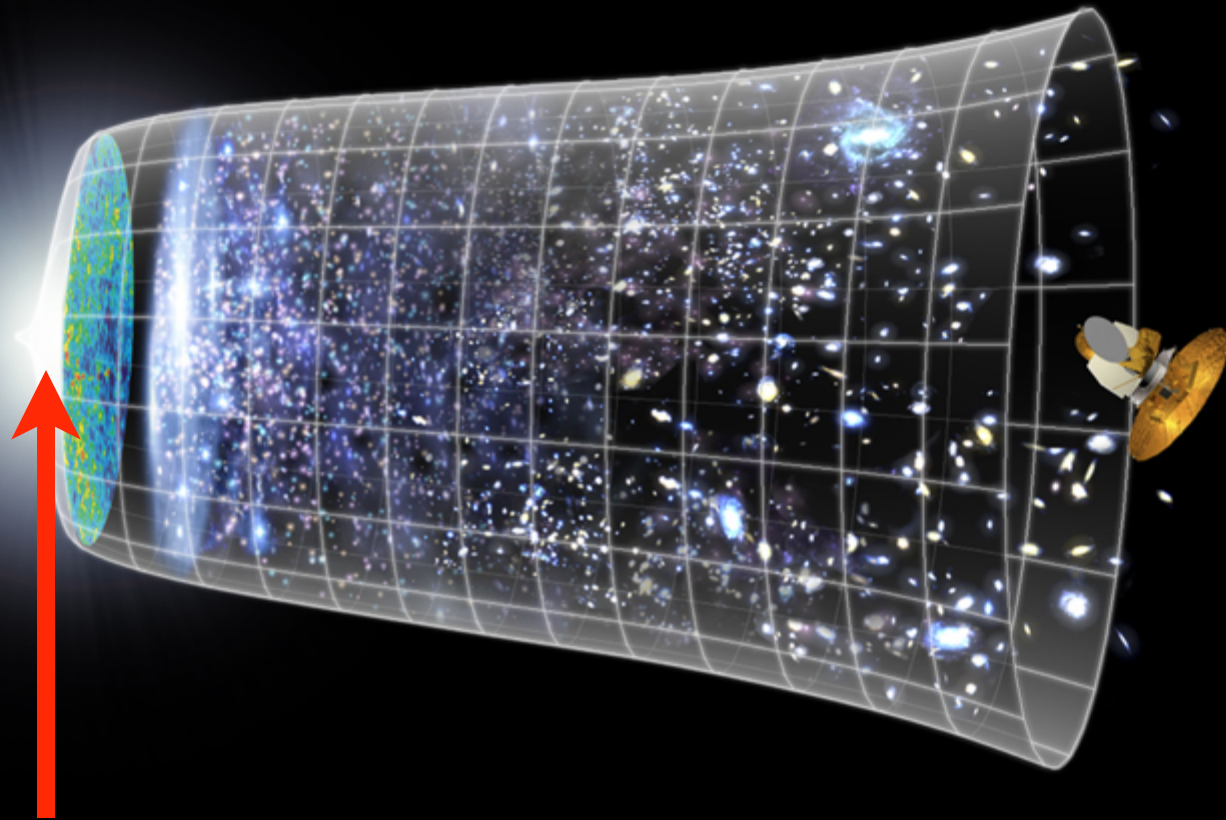


LET THERE BE LIGHT: THE BIG BANG

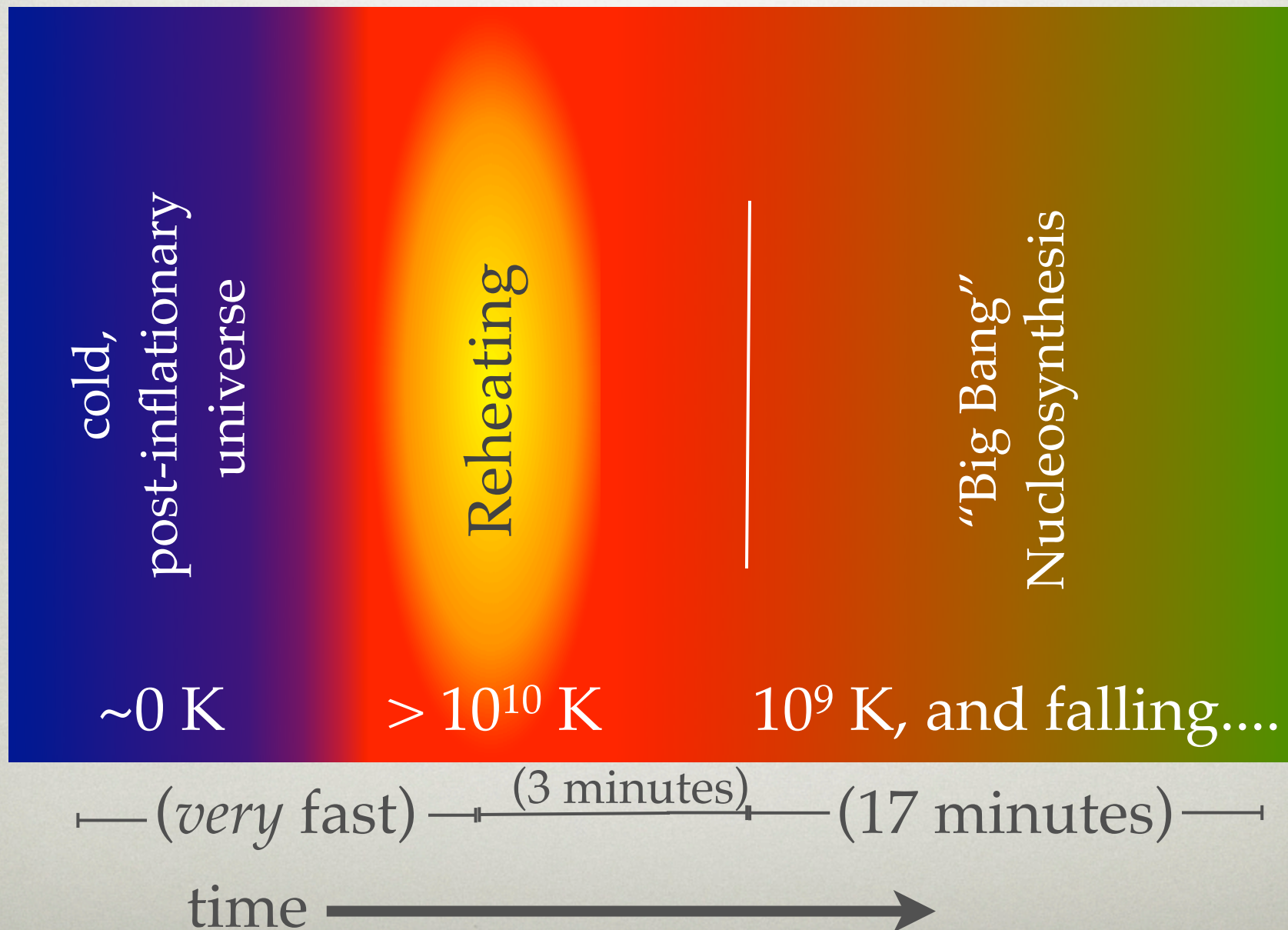
MARK WYMAN

74TH COMPTON LECTURE SERIES



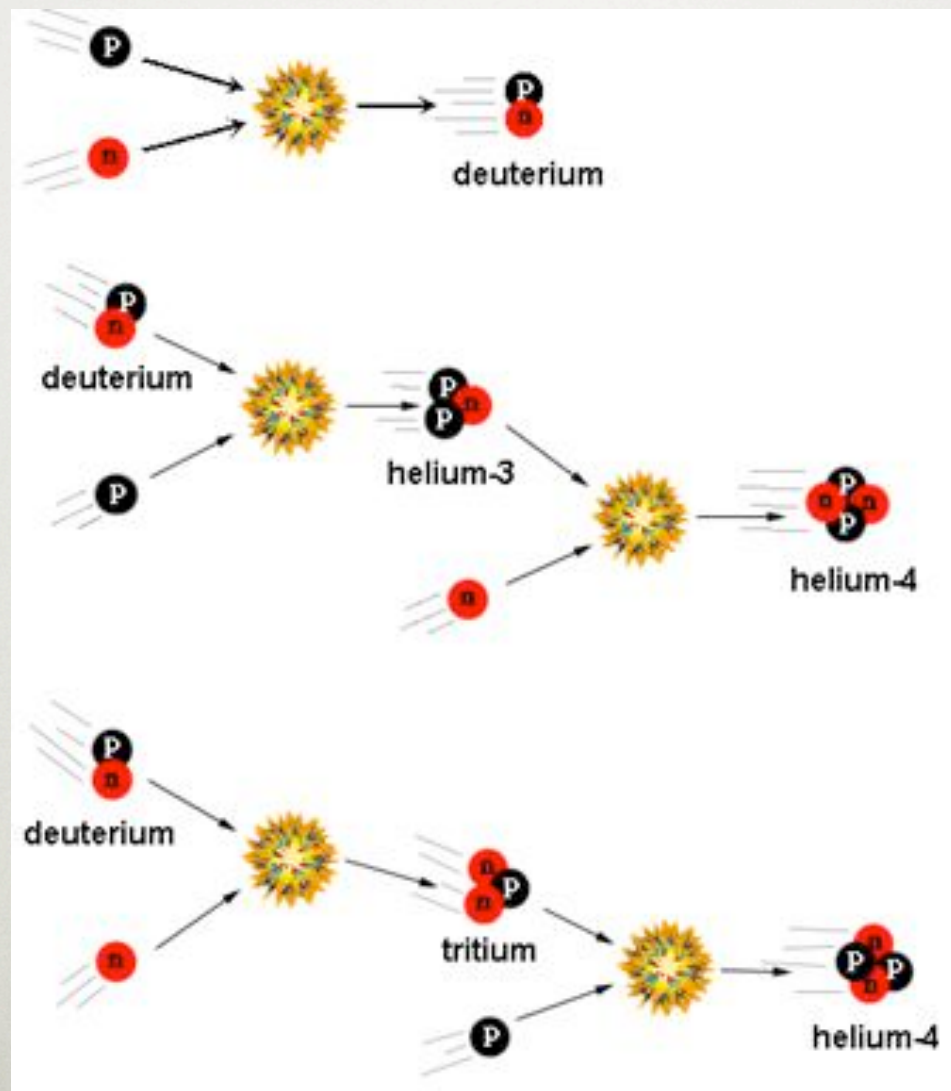
TODAY'S TOPIC

THE BIG BANG



FACTS

NUCLEOSYNTHESIS



NUCLEOSYNTHESIS

α, β, γ



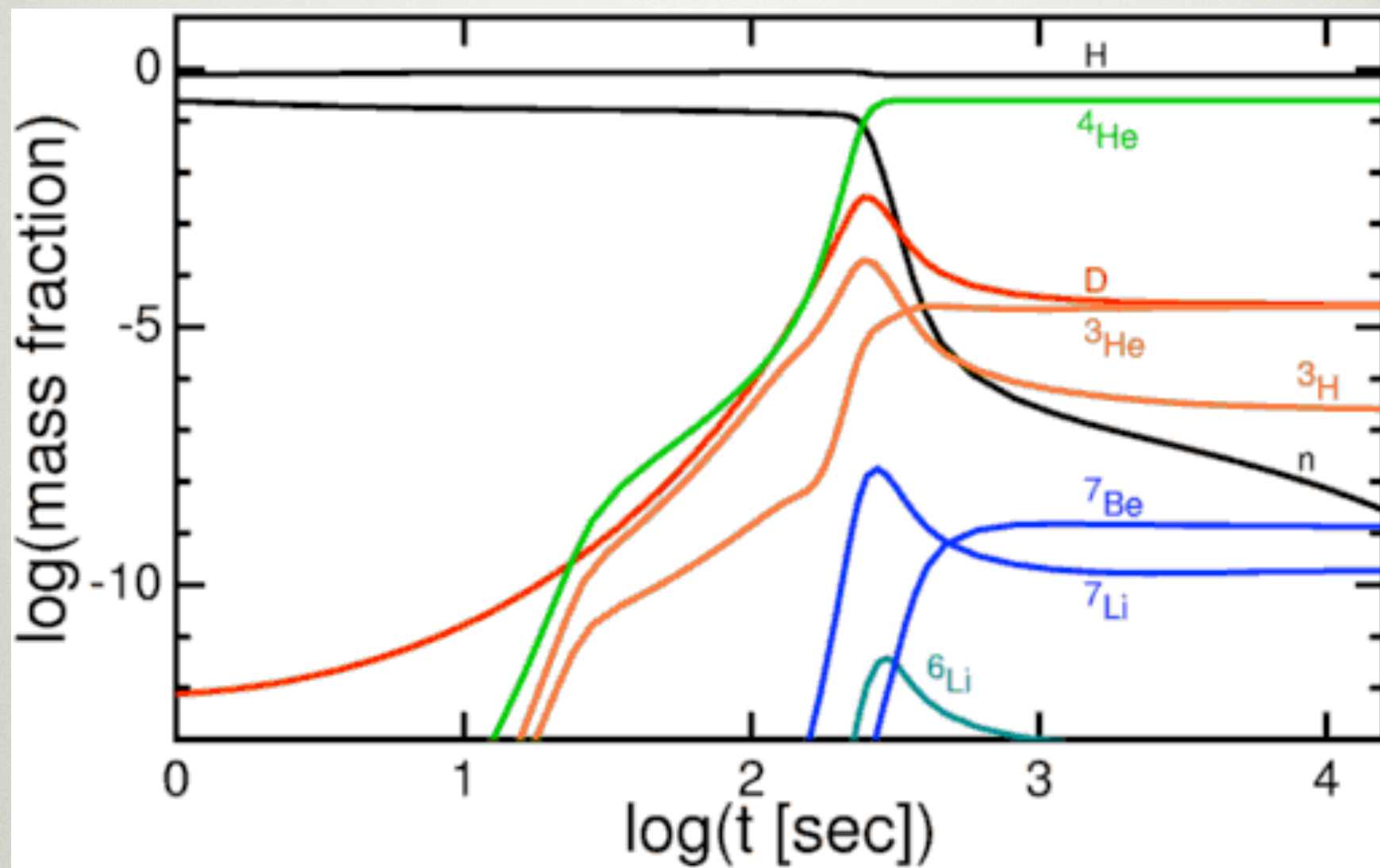
Alpher



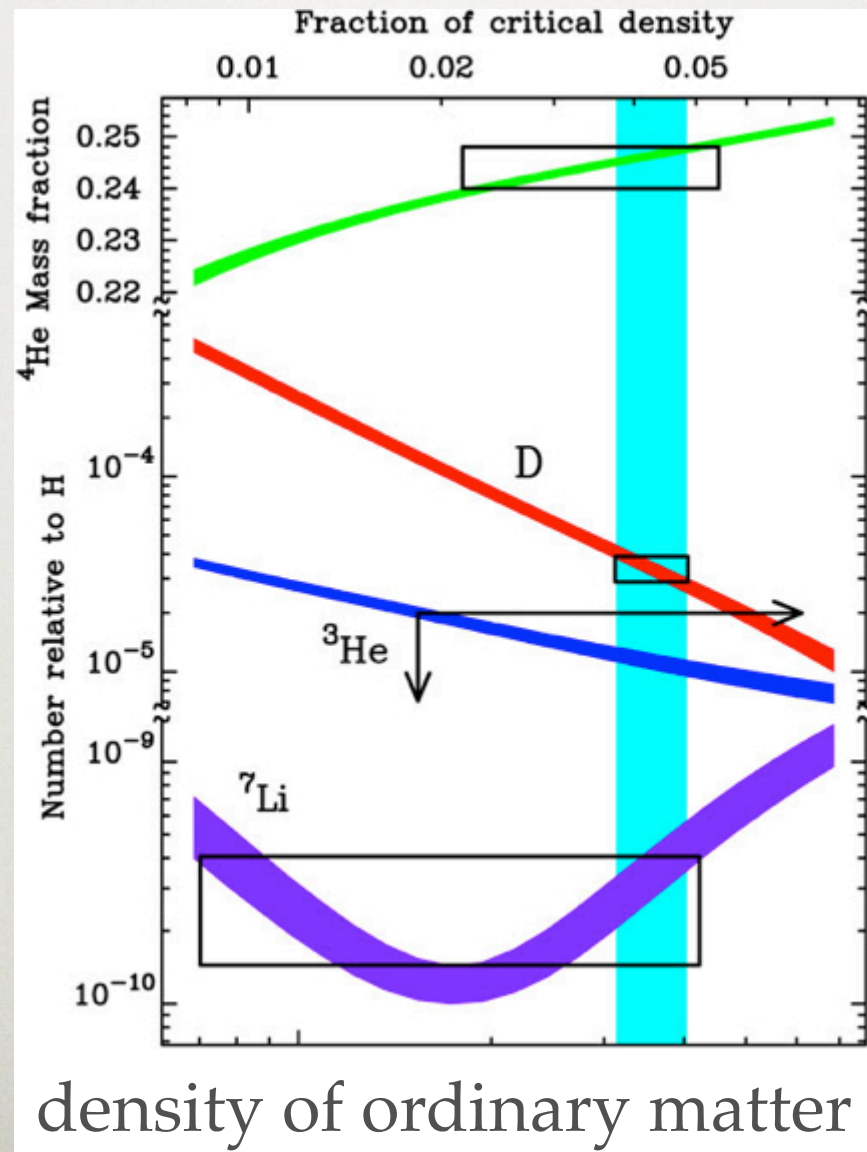
Bethe



Gamow



NUCLEOSYNTHESIS



THE LITHIUM PROBLEM

UMN-TH-2714/08

FTPI-MINN-08/32

August 2008

A Bitter Pill: The Primordial Lithium Problem Worsens

Richard H. Cyburt

*Joint Institute for Nuclear Astrophysics (JINA),
National Superconducting Cyclotron Laboratory (NSCL),
Michigan State University, East Lansing, MI 48824*

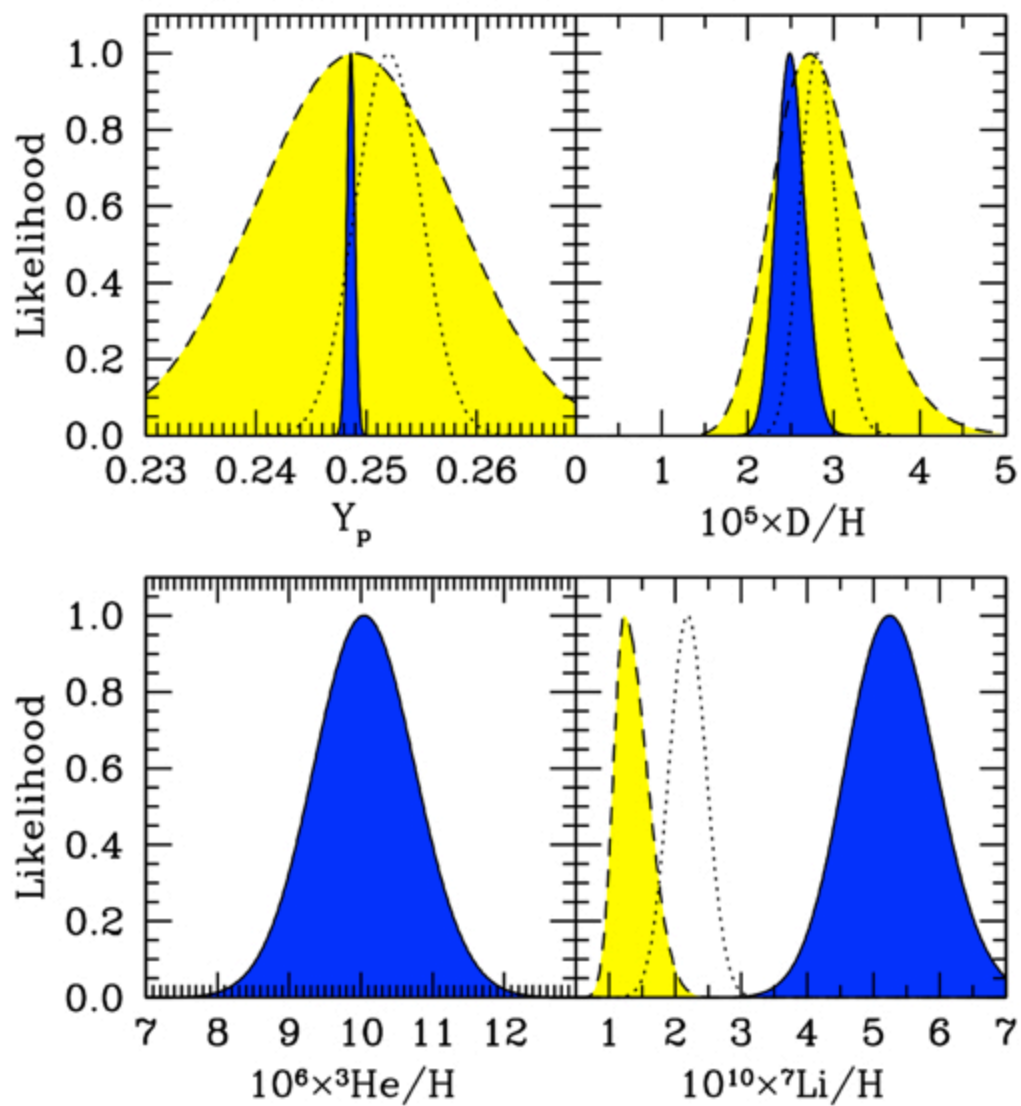
Brian D. Fields

*Departments of Astronomy and of Physics,
University of Illinois, Urbana, IL 61801*

Keith A. Olive

*William I. Fine Theoretical Physics Institute,
University of Minnesota, Minneapolis, MN 55455, USA*

THE LITHIUM PROBLEM

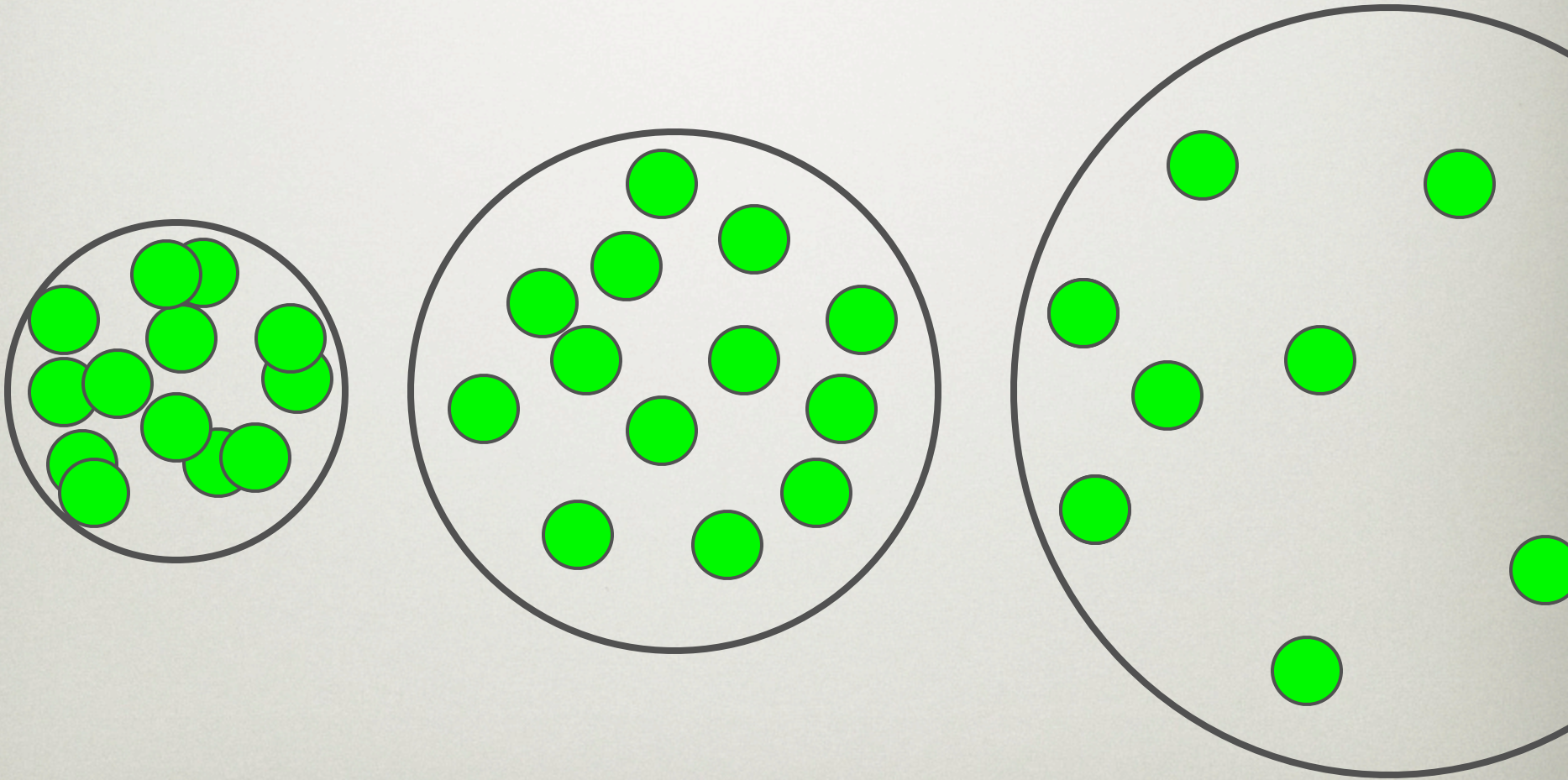


OBSERVATIONS

PREDICTIONS

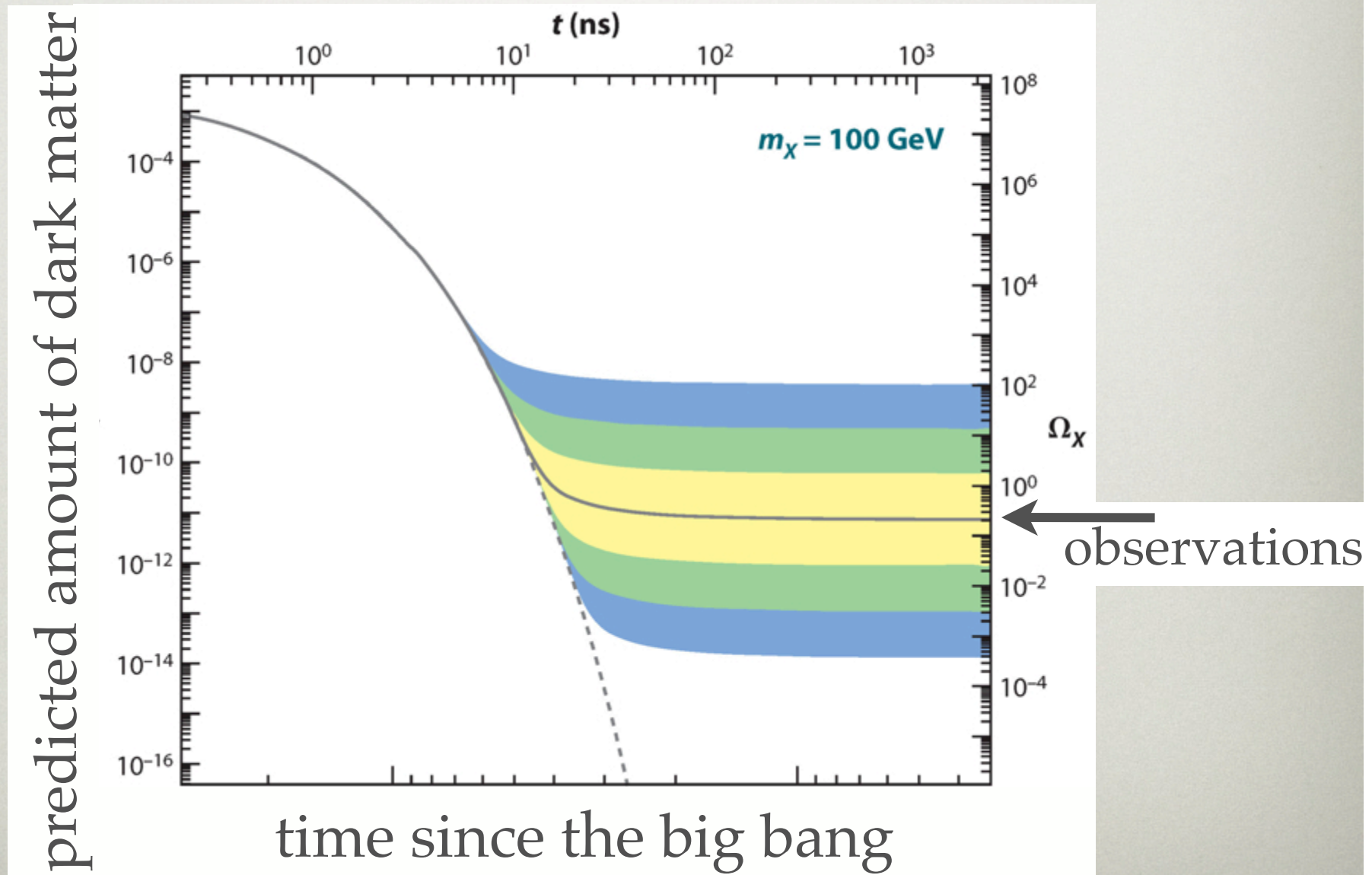
DARK MATTER “FREEZE OUT”

AKA the WIMP miracle

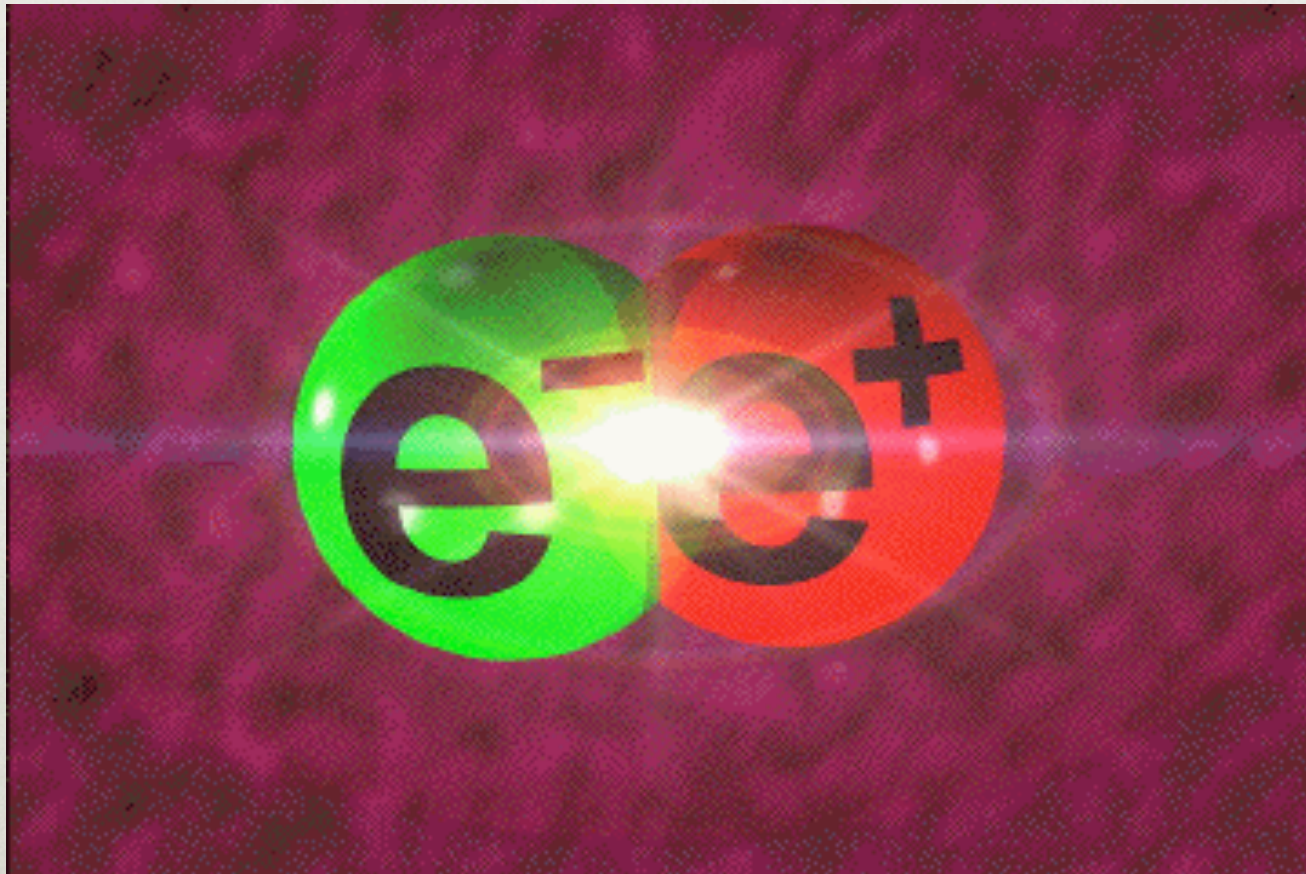


DARK MATTER “FREEZE OUT”

AKA the WIMP miracle

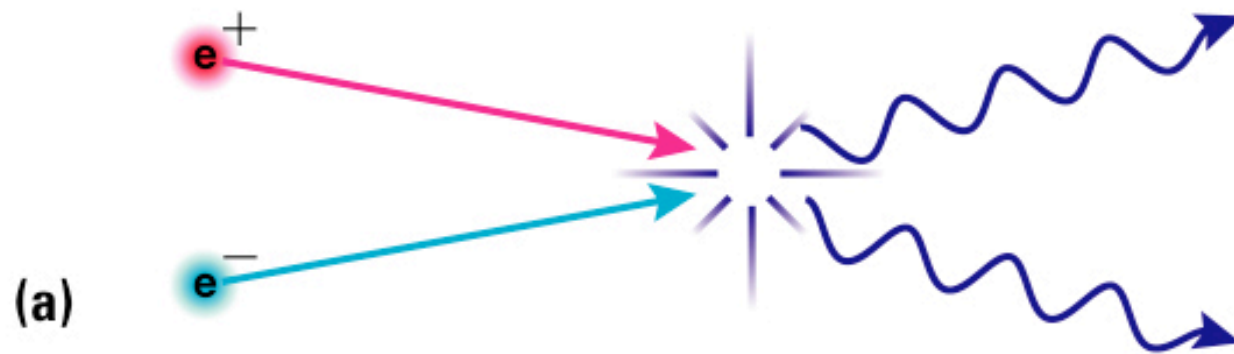


MATTER VS. ANTI-MATTER



WHAT IS ANTIMATTER?

- Each matter particle has an anti-particle
- Anti-particles have opposite electrical charge
- Anti-matter gravitates like matter





10,000,000,001

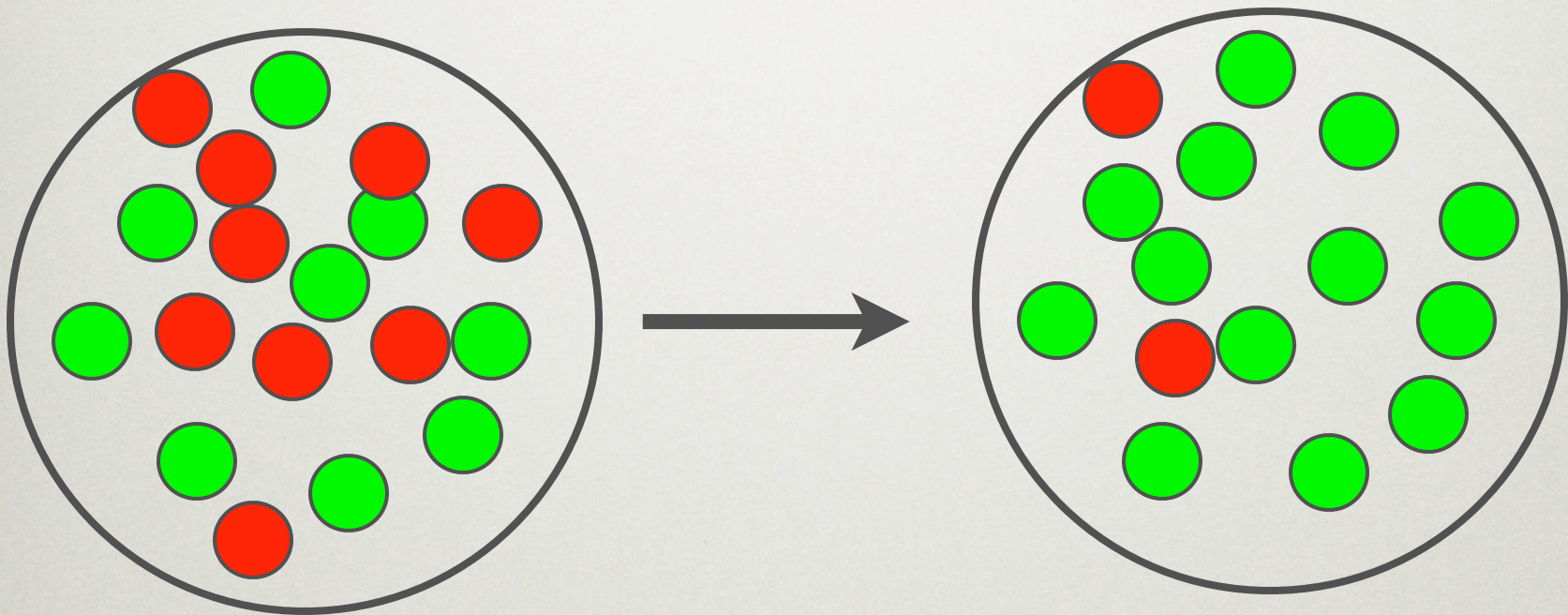
10,000,000,000

MATTER

ANTI-MATTER

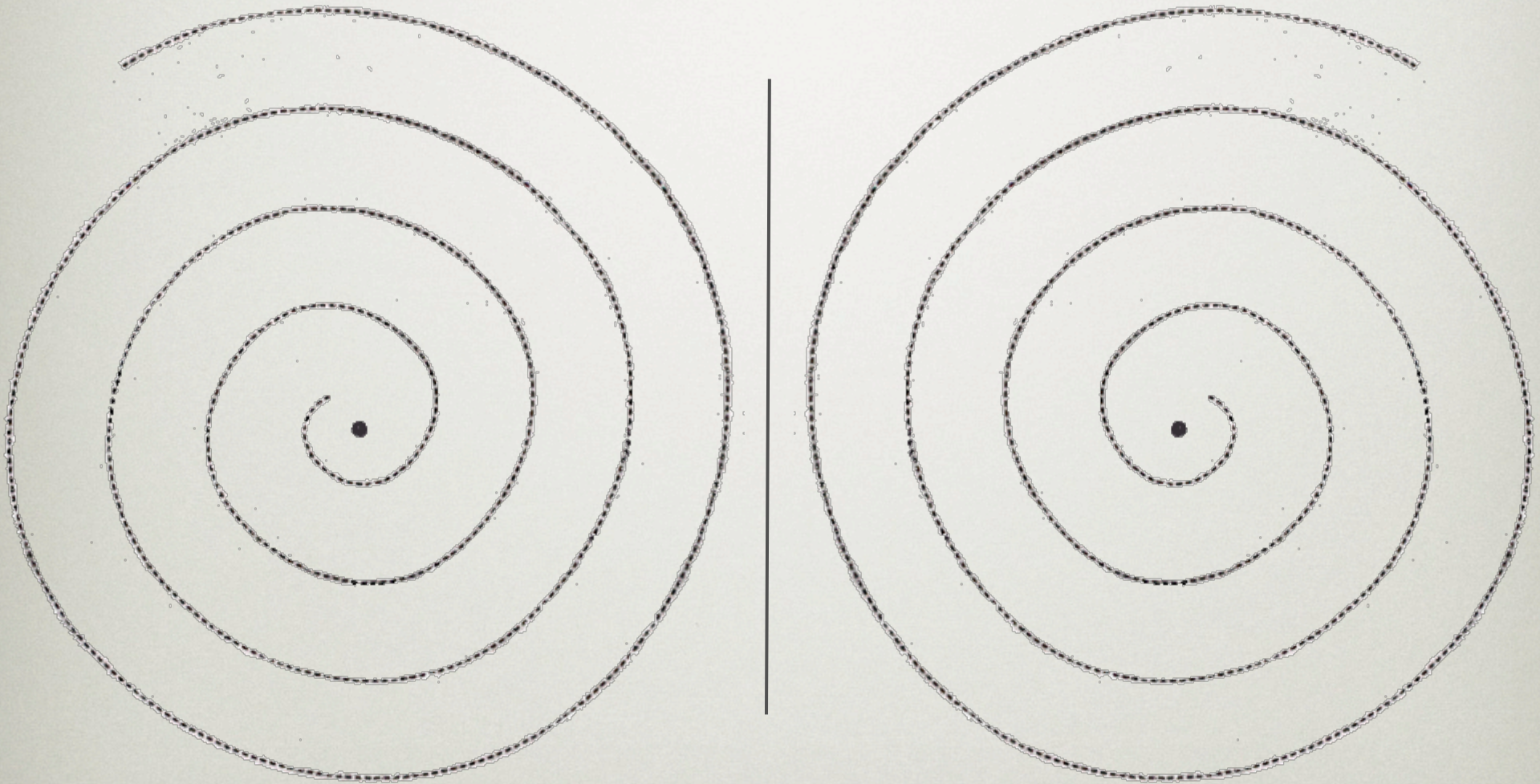
3 THINGS ARE NEEDED TO
GENERATE MORE MATTER
THAN ANTI-MATTER

1) PROCESSES THAT CAN MAKE MORE **MATTER** THAN **ANTIMATTER**



status: lots of ideas, none proven

2) VIOLATION OF “CHARGE-PARITY” SYMMETRY



status: experimentally confirmed

3) REACTIONS TAKE PLACE OUT OF EQUILIBRIUM



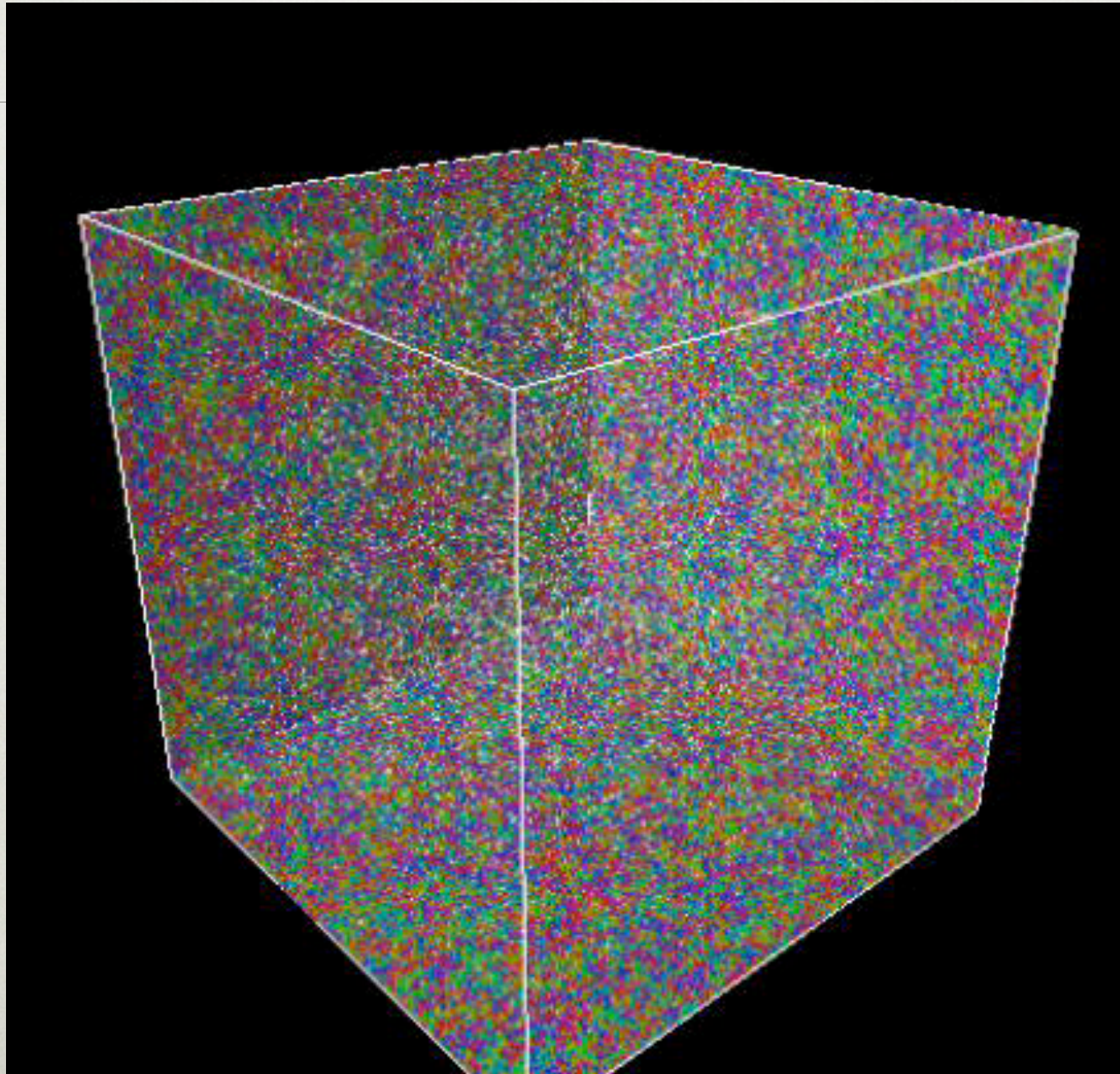
status: few ideas, none proven

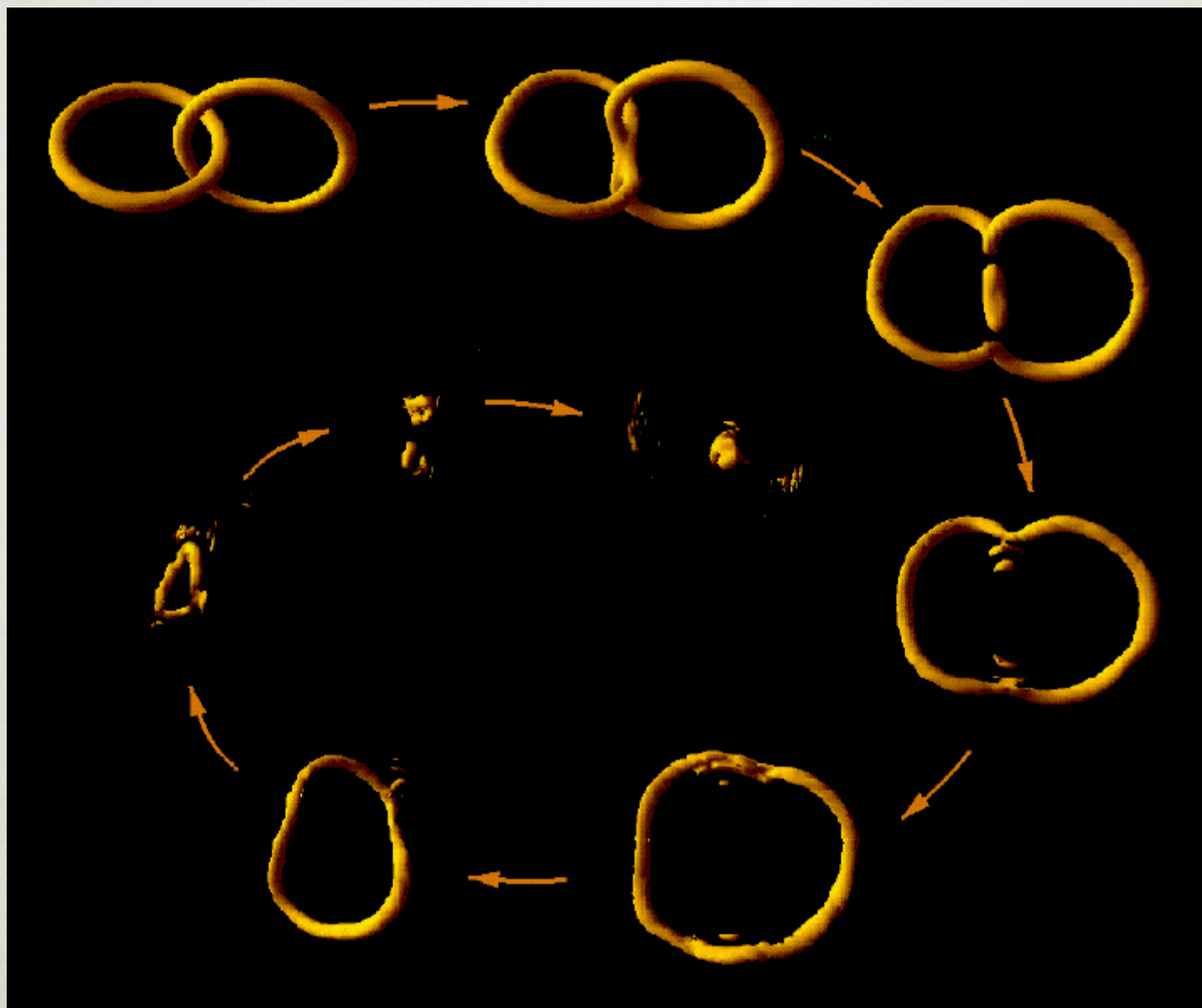
SPECULATIONS

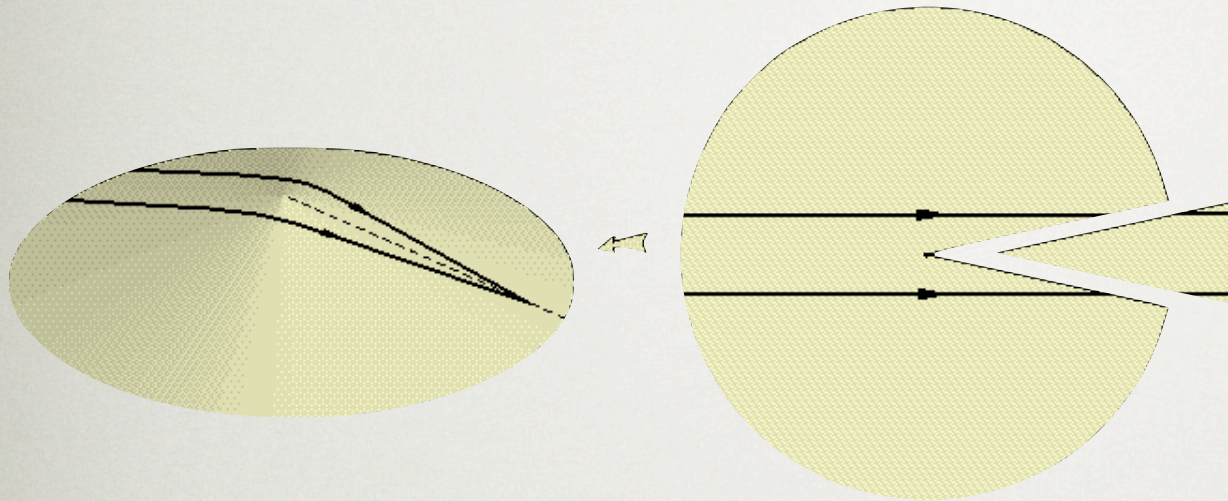
COSMIC (SUPER)STRINGS



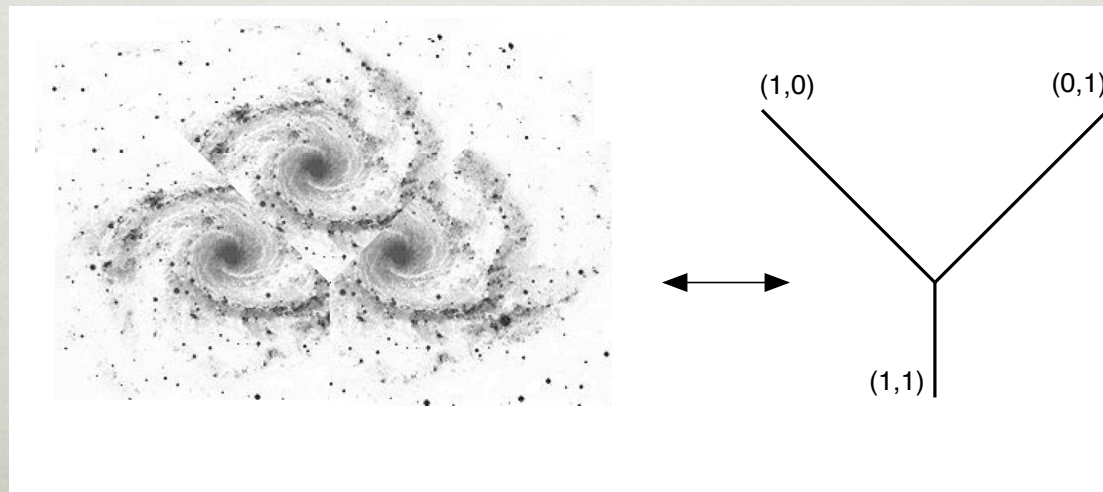
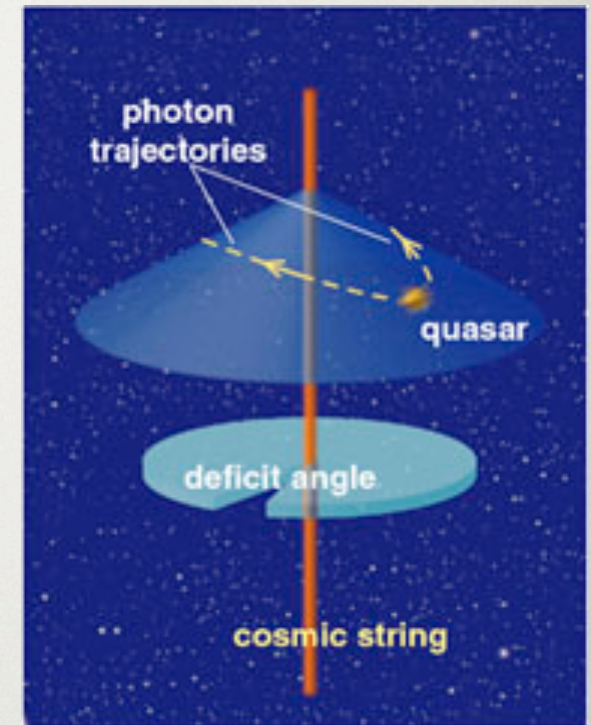
HOW STRINGS FORM:







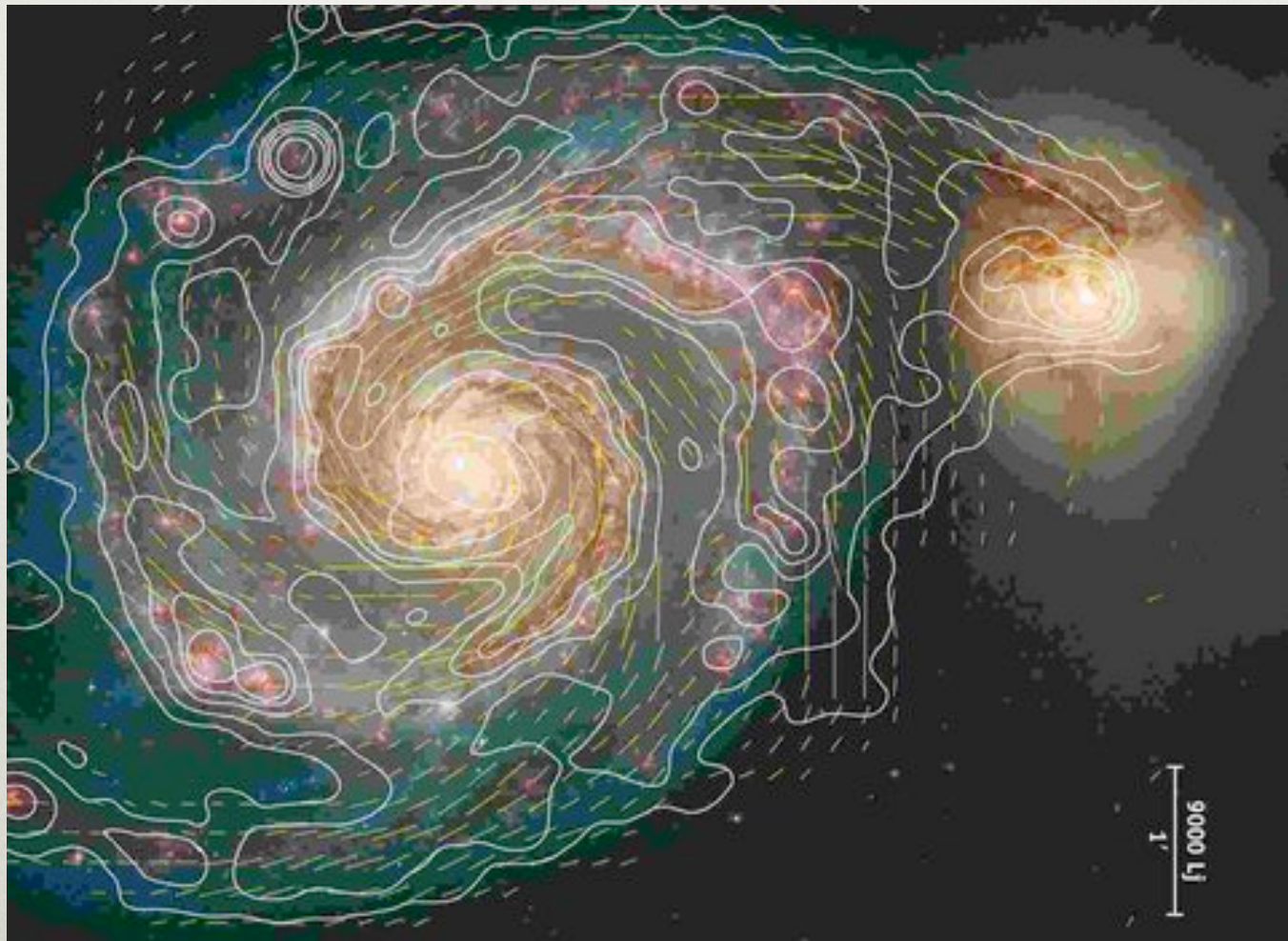
Deficit Angle

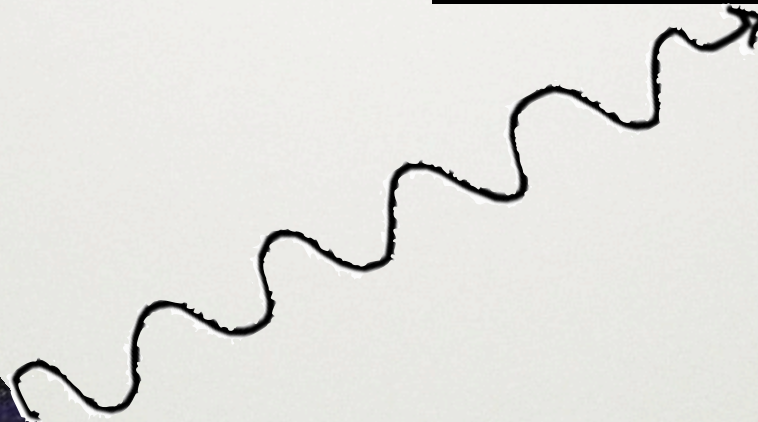
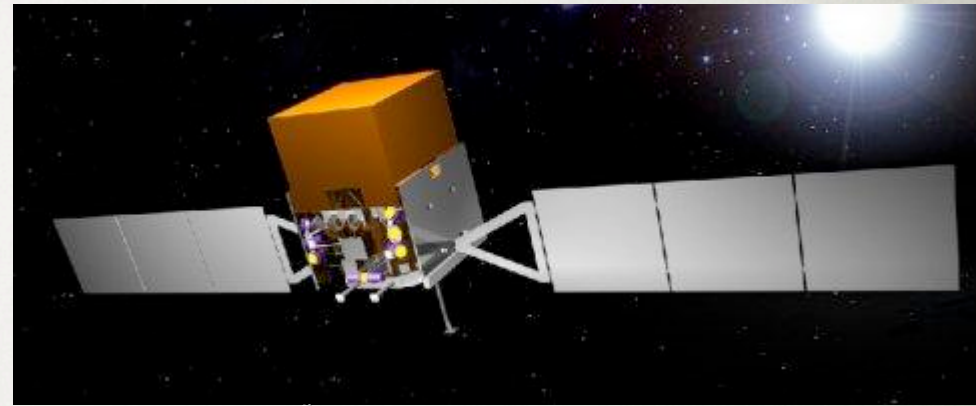
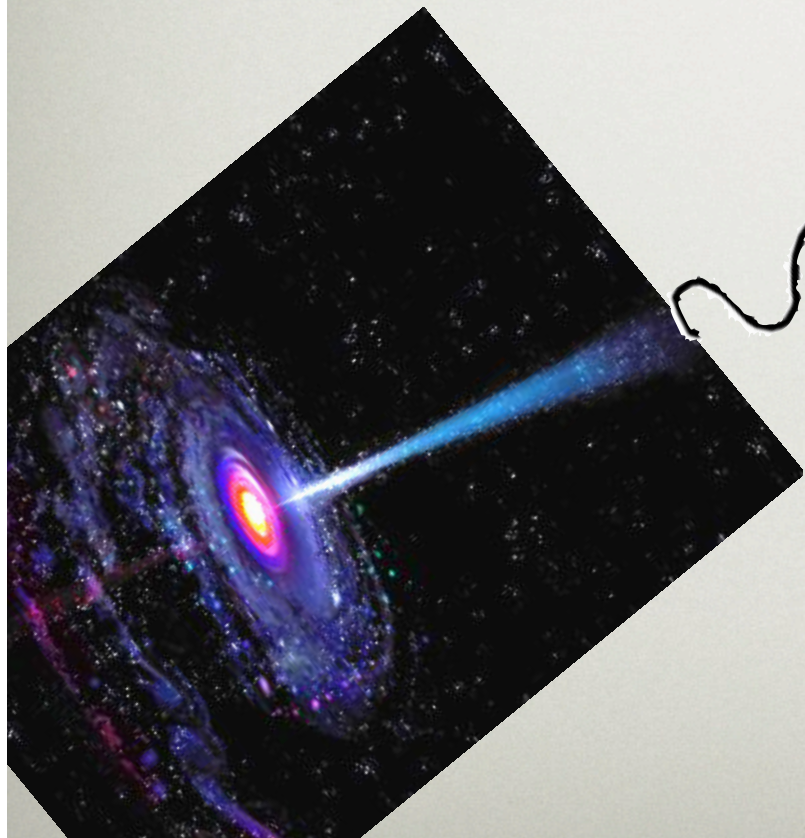


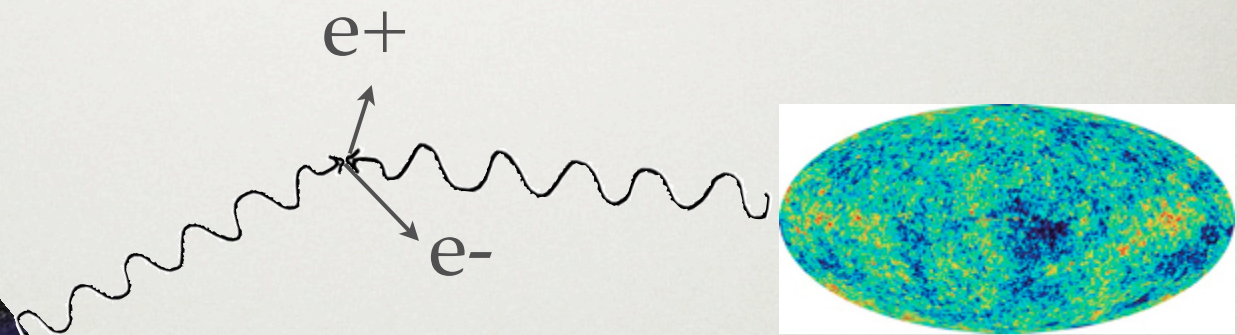
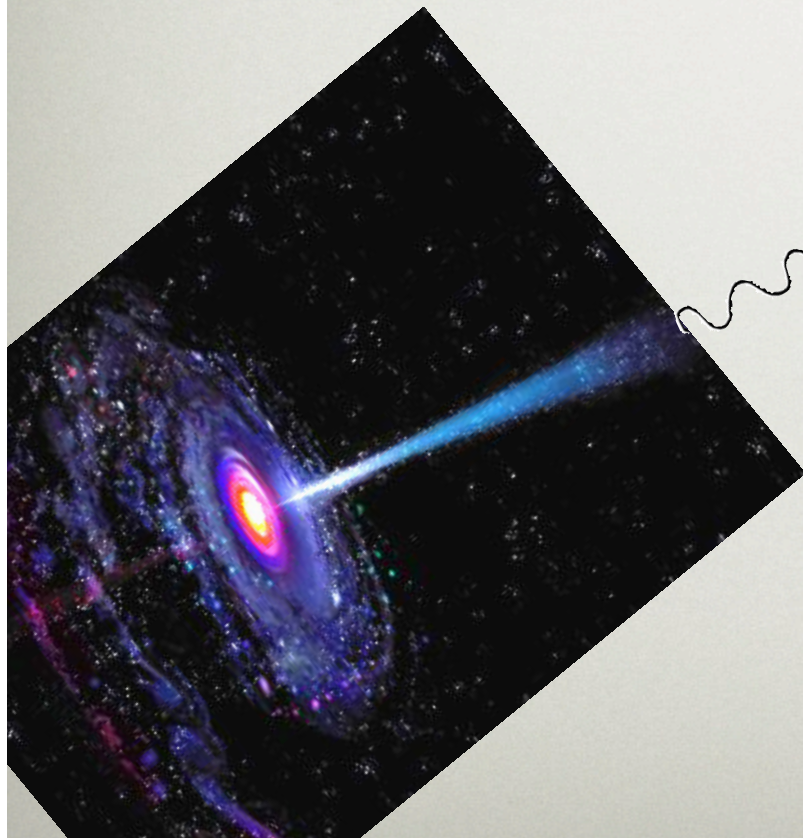
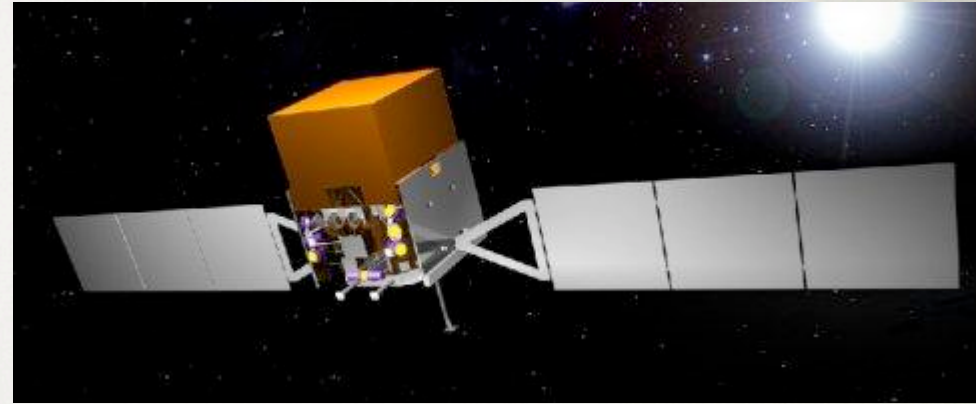
PRIMORDIAL MAGNETISM



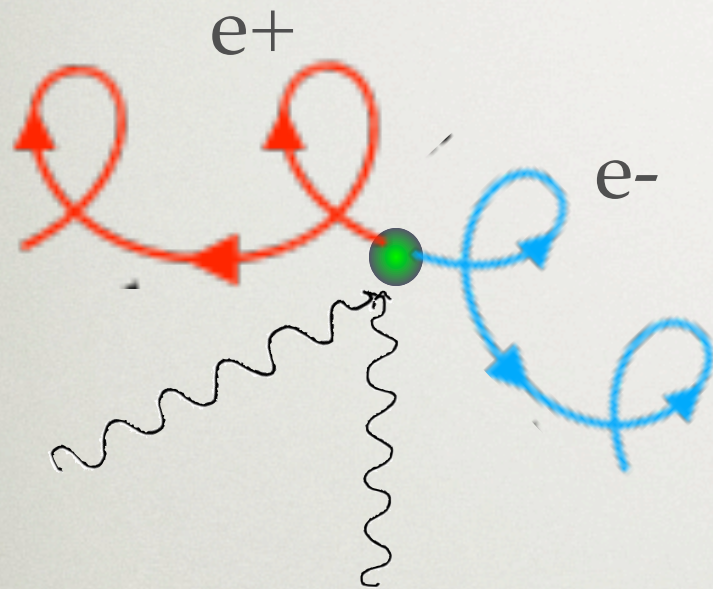
EVERY GALAXY HAS A MAGNETIC FIELD







With Magnetic Field



Without Magnetic Field

