

What are we talking about?

- Fundamental question:

**Why/how is our Universe made of
MATTER?**

- We call MATTER what makes everything around us.
- MATTER is ultimately made of
→ **PARTICLES**
- Constituent particles can be divided into
 - **QUARKS**, that make composite particles called hadrons, like the proton and the neutron.
 - **LEPTONS**, which can be charged, like the **electron**, or neutral, like the **neutrinos**

LEPTONS		
neutrino e	neutrino μ	neutrino τ
electron	muon	tauon

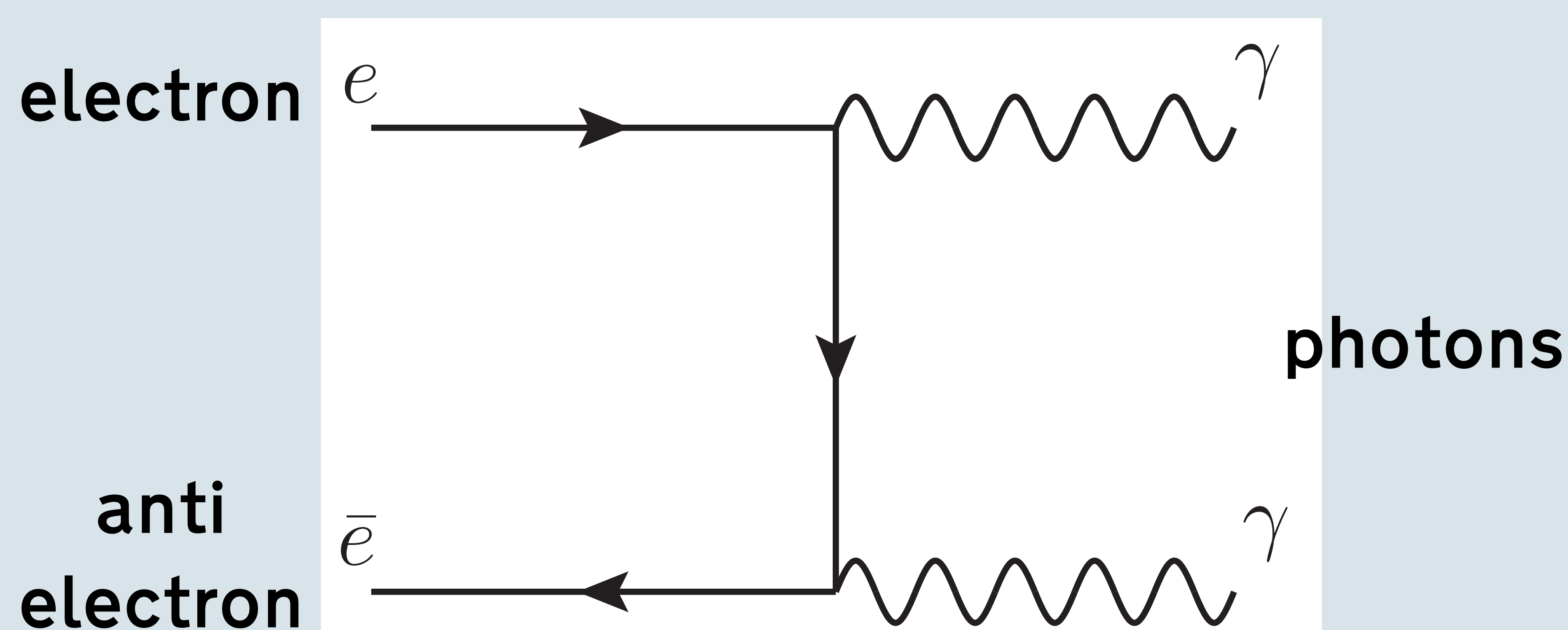
- In order to describe our Universe, we need also

ANTIMATTER

- It is the exact “mirror” of common matter. Each antiparticle has the same mass of the corresponding particle, but **opposite** properties, e.g. opposite electric charge.

Opposites destroy!

- Matter and antimatter **annihilate** mostly into massless particles: PHOTON, i.e. **LIGHT**

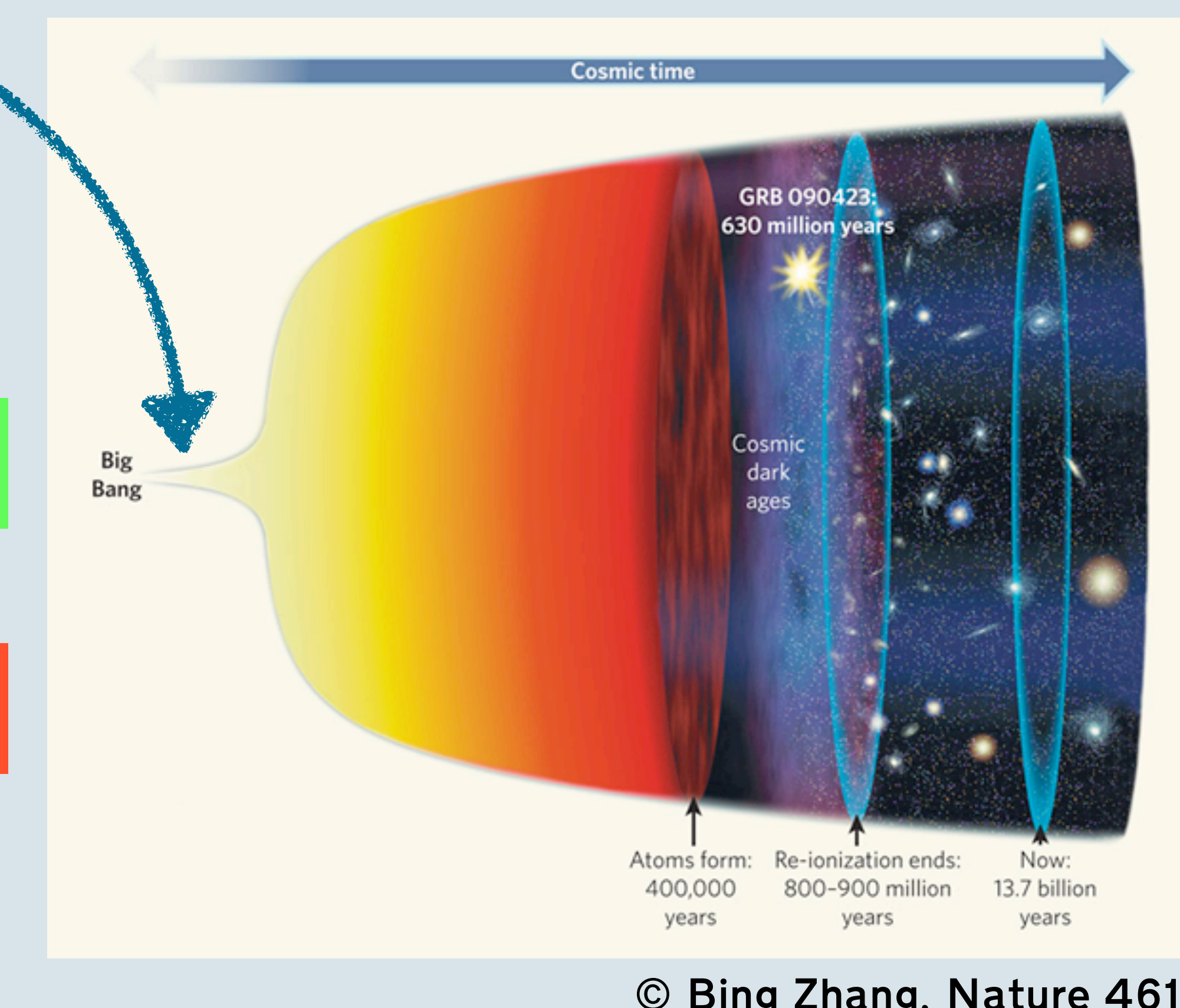


Why is antimatter much rarer than matter in our Universe, so that everything could appear?

In the Universe

- The Universe evolves from an initial point, the **BIG BANG**, up to **TODAY**
- If we postulate a symmetrical initial condition, we have

MATTER
+
ANTIMATTER
=
NOTHING!
(energy)



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Asymmetry

- We need

Asymmetry!

- Matter and antimatter dynamically produced in a different amount.
- **HOW?**

MATTER
+
ANTIMATTER
=
MATTER!

Leptogenesis

- I work on a theory that uses a heavy kind of **neutrinos** to produce matter/antimatter asymm.
- Heavy neutrinos can decay into **leptons** or **anti-leptons**, but lepton decay is favourable:

Leptons > Antileptons

- The asymmetry is then extended to the quark sector, so that the final result is

Matter > Antimatter!

- There are many questions I am trying to answer:
 - how many neutrinos do we need?
 - can we reproduce the experimental results?
 - can we have some predictions on unknown parameters (e.g. neutrino masses)?
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THE QUEST HAS JUST STARTED!