

Tough Question:

What will it take to identify the mechanism for baryogenesis or leptogenesis? Are there scenarios that could conceivably be considered to be established by experimental data in the next 20 years? What experiments are required to achieve this?

Leptogenesis Models

- *predicts light neutrino (< 0.1 eV)*
- *Majorana neutrinos*
- *CPV in oscillations (but phase not predicted)*
- *Traditional leptogenesis via decay of heavy (10^9 - 10^{10} GeV) neutrino requires high reheat scale after inflation*
 - *gravitino problem*
 - *problem with B-L violation (neutron anti neutron osc)*
- *models with lower energy leptogenesis, lighter particles more constrained and and testable*

Affleck-Dine

- *requires supersymmetry (but does not predict spectrum)*
- *requires inflation with low scale*
 - ➔ *no inflationary B-modes*
- *Q-ball dark matter potential (but not necessary) smoking gun*
- *high (10 TeV) scale SUSY could give rare processes e.g. $\mu \rightarrow e \gamma$*

Electroweak Baryogenesis

- *Strongly first order electroweak phase transition*
- *new bosons strongly coupled to Higgs*
 - ➔ *top squarks (with susy CPV phases)*
 - ➔ *2HDM (with CPV in Higgs sector)*
 - ➔ *singlet + some new source of CPV*
- *Modified Higgs trilinear*
- *Visible Electric Dipole Moments (right around the corner?)*

Other

- *traditional GUT baryogenesis needs to produce net $B-L$ (else Baryon number washed out by sphalerons)*
 - ➡ *replaced by leptogenesis*
- *late gravitino decay*
 - ➡ *susy, heavy gravitino, RPV*
- *“Baryogenesis in thermal equilibrium” (effective temporary CPT violation via the Cohen-Kaplan Ilion)*
 - ➡ *isocurvature fluctuations, unless low inflation scale*
 - ➡ *new CPV not necessary*
- *Baryosymmetric baryogenesis*
 - ➡ *Dark Matter is antibaryonic and destroys baryons*

Relevant experiments for baryogenesis

- ➔ *search for B modes in CMB*
- ➔ *gravity wave search for evidence of 1st order PT*
- ➔ *axion dark matter search*
- ➔ *Q ball search*
- ➔ *exotic dark matter searches, e.g. asymmetric, anti B carrying..*
- ➔ *$0\nu\beta\beta$ decay*
- ➔ *N_{eff} light relativistic species from CMB/LSS*
- ➔ *CPV in ν oscillations*
- ➔ *ν mass hierarchy*
- ➔ *absolute ν mass*
 - *Katrin*
 - *Cosmology: LSS, CMB*
- ➔ *B violation, proton decay*
- ➔ *EDM searches*
- ➔ *CPV and new flavor physics in meson mixing and decays*
- ➔ *search for new bosons at colliders e.g. light stop*
- ➔ *triple Higgs coupling measurement in colliders*
- ➔ *susy search in colliders, esp stealthy versions with near degeneracies*
- ➔ *indirect susy: $\mu g-2$, $\mu \rightarrow e \gamma$,*
- ➔ *precision measurement of Higgs and new particle couplings*