Baryogenesis and Dark Matter from B mesons

Abstract: In [1] a new mechanism to simultaneously generate the baryon asymmetry of the Universe and the Dark Matter abundance has been proposed.

The Standard Model of particle physics succeeds to describe many physical processes and it has been tested to a great accuracy. However, it fails to provide a Dark Matter candidate, a so far undetected component of matter which makes up roughly 25% of the energy budget of the Universe. Furthermore, the question arises why there is a more matter (or baryons) than antimatter in the Universe taking into account that cosmology predicts a Universe with equal parts matter and anti-matter. The mechanism to generate a primordial matter-antimatter asymmetry is called baryogenesis. Any successful mechanism for baryogenesis needs to satisfy the three Sakharov conditions [2]:

- violation of charge symmetry and of the combination of charge and parity symmetry
- violation of baryon number
- departure from thermal equilibrium

In this paper [1] a new mechanism for the generation of a baryon asymmetry together with Dark Matter production has been proposed.

The mechanism proposed to explain the observed baryon asymetry as well as the production of dark matter is developed around a fundamental ingredient: a new scalar particle Φ. The Φ particle is massive and would dominate the energy density of the Universe after inflation but prior to the Bing Bang nucleosynthesis. The same particle will directly decay, out of thermal equilibrium, to $b/\bar{b}$ quarks and if the Universe is cool enough $\sim \mathcal{O}(10$ MeV), the produced b quarks can hadronize and form B-mesons.

The next stage of the mechanism is to produce the visible asymmetry between matter and antimatter, so it must fullfill the Sakharov conditions. One was already accomplished by the departure of thermal equilibrium when Φ decays to the b quarks. The second one is accomplished by violating an important symmetry of the Universe, charge and parity (CP). The neutral B mesons, B_q^0 will quickly oscillate between meson and anti-meson state and generate the required CP violation. The last Sakharov condition regarding the baryon number violation is realized subtly. The proposed model "relaxes" the baryon number violation by requiring that the B mesons, after oscillating, decay to visible sectors baryons and to Dark Matter. The CP violation originated from the oscillations will also be transfered to the Dark sector, which means that in both sectors there is a matter-antimatter assymetry.

The proposed model introduces the baryogenesis and the production of Dark Matter in a natural way to solve some open questions left by the SM. Finally, this mechanism predicts unique experimental signals: a positive leptonic asymmetry in B meson decays, a new decay of B mesons into a baryon and missing energy, and a new decay of b-flavored baryons into

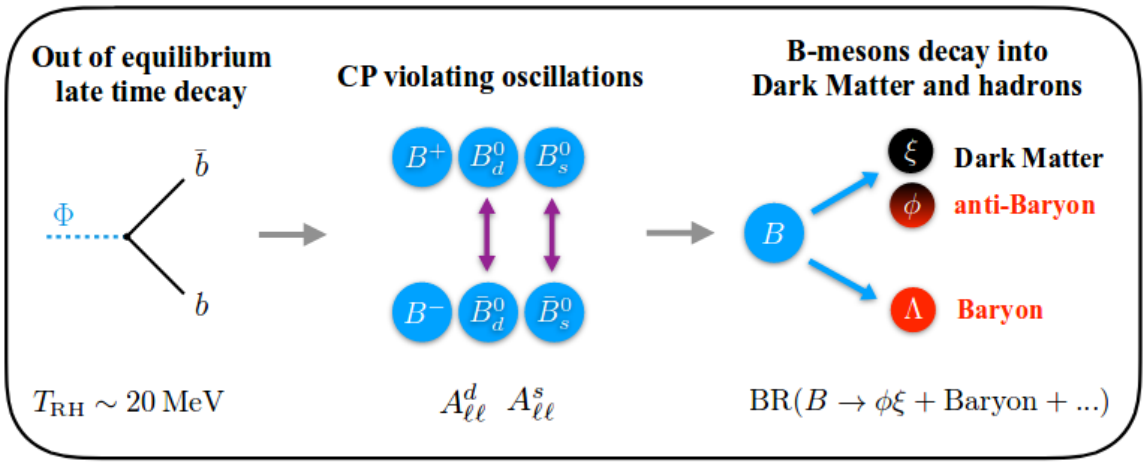

Figure 1: Schematic representation of the proposed mechanism.

mesons and missing energy. These three observables are testable at current and upcoming collider experiments, allowing for a distinct probe of this mechanism.

References

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[2] A. D. Sakharov, Pisma Zh. Eksp. Teor. Fiz. **5** (1967) 32 [JETP Lett. **5** (1967) 24] [Sov. Phys. Usp. **34** (1991) no.5, 392] [Usp. Fiz. Nauk **161** (1991) no.5, 61]. doi:10.1070/PU1991v034n05ABEH002497