A possible scenario for generation of particle number asymmetry with inflaton background has been investigated. We study a simple model which may generate asymmetry through interaction with inflaton field. This model has CP violating and particle number violating features. We compute time evolution of particle number asymmetry in pre-heating era by using quantum field theory combined with density matrix.

### Research background

- One of unsolved problem in both particle physics and inflationary cosmology: Baryon Asymmetry
- The origin of the asymmetry: oscillating inflaton field couples with a complex scalar field carries U(1) charge; particle number asymmetry (PNA).
- A possible scenario: the asymmetry was generated during preheating era. During this era, an inflaton decays into the another (lighter) particles and the universe turns into the reheating era.
- In this work, we study a simple model which generates PNA through "interactions" and compute its time evolution using quantum field theory with density operator.

### The Model

The action is given by

\[
\mathcal{L}_0 = \frac{1}{2} \epsilon^{ijk} \partial_i N \dot{\phi}_j \dot{\phi}_k
\]

\[
\mathcal{L}_\text{int} = \int \frac{d^4k}{(2\pi)^4} \left[ \frac{1}{2} (\dot{N}^2 - N^2) + \frac{1}{2} \rho_\phi \right]
\]

The potential reads,

\[
V(N) = \frac{M_0^2}{2} (N - V)^2
\]

\[
\phi_i = N - V \text{ (shifted field)}
\]

Decomposed complex scalar: real and imaginary.

\[
\phi = \phi_\text{real} + i \phi_\text{imag}
\]

Effective masses:

\[
m_{\phi_1}^2 = m_0^2 + B^2
\]

\[
m_{\phi_2}^2 = m_0^2 - 2B^2
\]

### Summary and Conclusion

- We study an interacting model in which particle number asymmetry is generated through oscillating inflaton field coupled with a complex scalar field.
- The current for the particle and anti-particle asymmetry is given up to the first order of cubic coupling $A$.