

Neutrino mass in type Ib seesaw model and the early universe



Bowen Fu

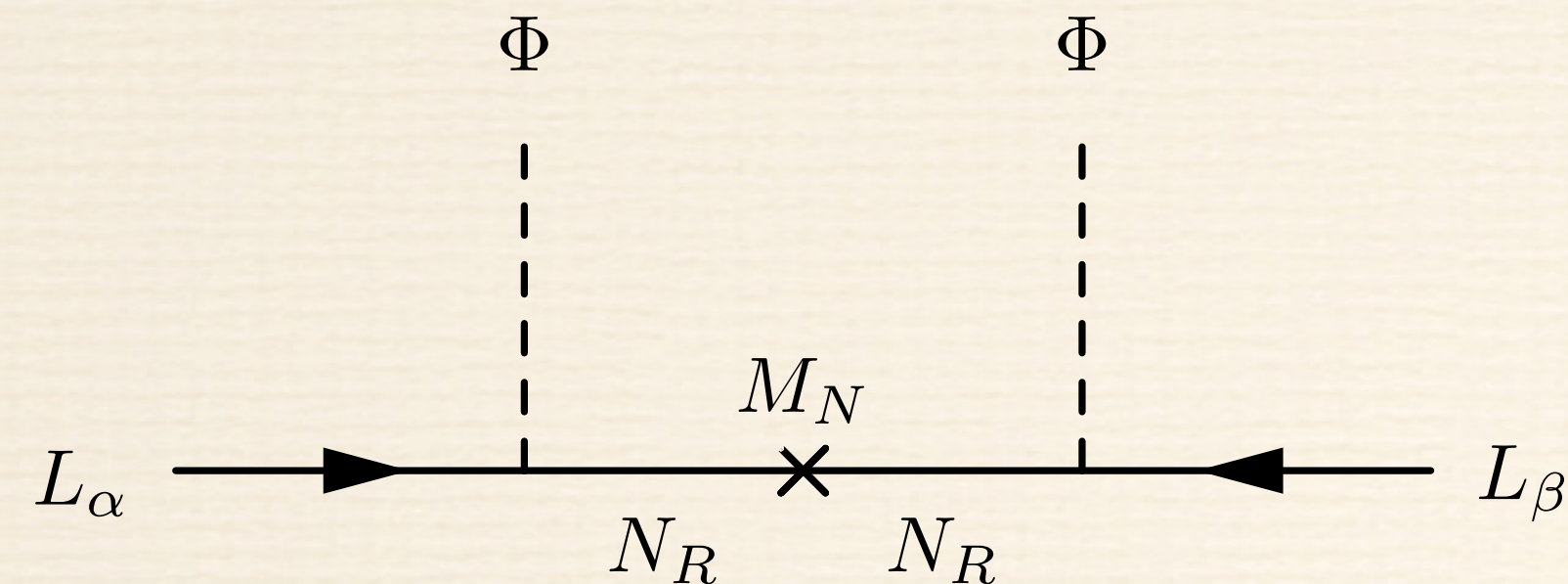
Supervised by Steve King

In collaboration with Marco Chianese

UK HEP Forum 2022: Neutrinos: What? Where from? Where to?

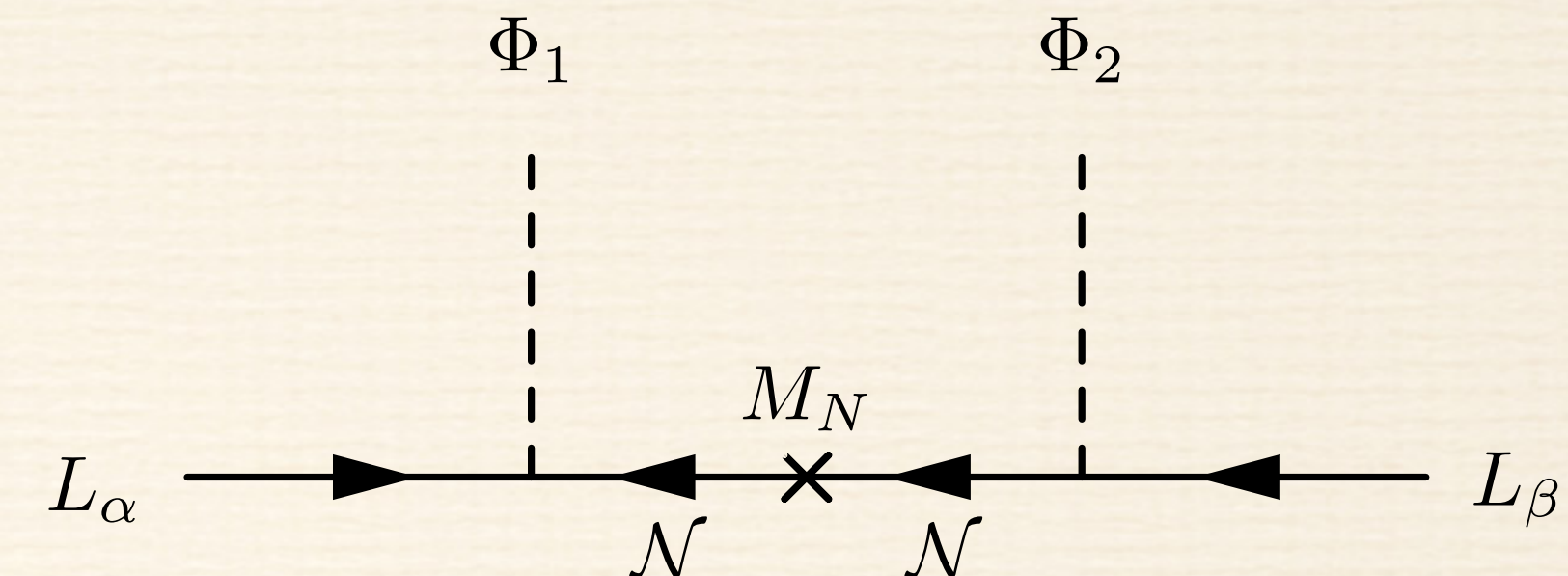
Type Ib Seesaw Model

- ❖ Traditional type I seesaw mechanism (type Ia)



- ❖ At least 2 Majorana RH neutrinos + 1 Higgs
- ❖ 1 Yukawa coupling for each RH neutrino
- ❖ Littlest Seesaw model: 2 free parameters after considering neutrino mass and mixing
- ❖ Large coupling and GeV scale heavy neutrino cannot be achieved simultaneously $m \propto \frac{Y^2 v^2}{M_N}$

- ❖ Type Ib seesaw mechanism



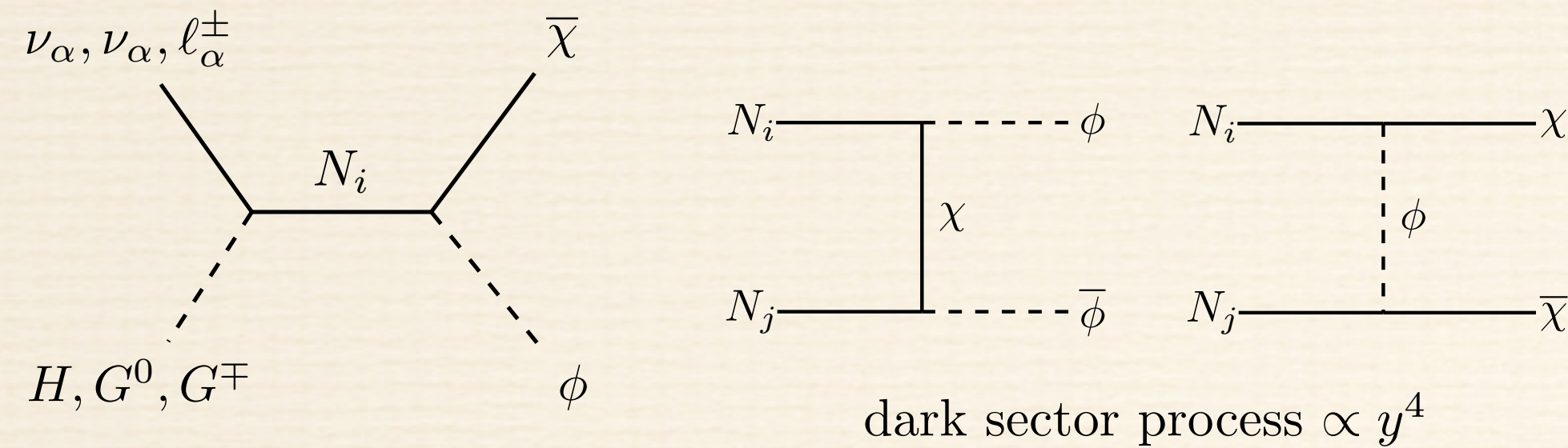
- ❖ 1 Dirac heavy neutrino + 2 Higgs
- ❖ 1 Yukawa coupling for each Higgs
- ❖ 3 free parameters after considering neutrino mass and mixing
- ❖ 1 large coupling, 1 small coupling and 1 GeV scale heavy neutrino at the same time $m \propto \frac{Y_1 Y_2 v_1 v_2}{M_N}$

Predictability

Testability

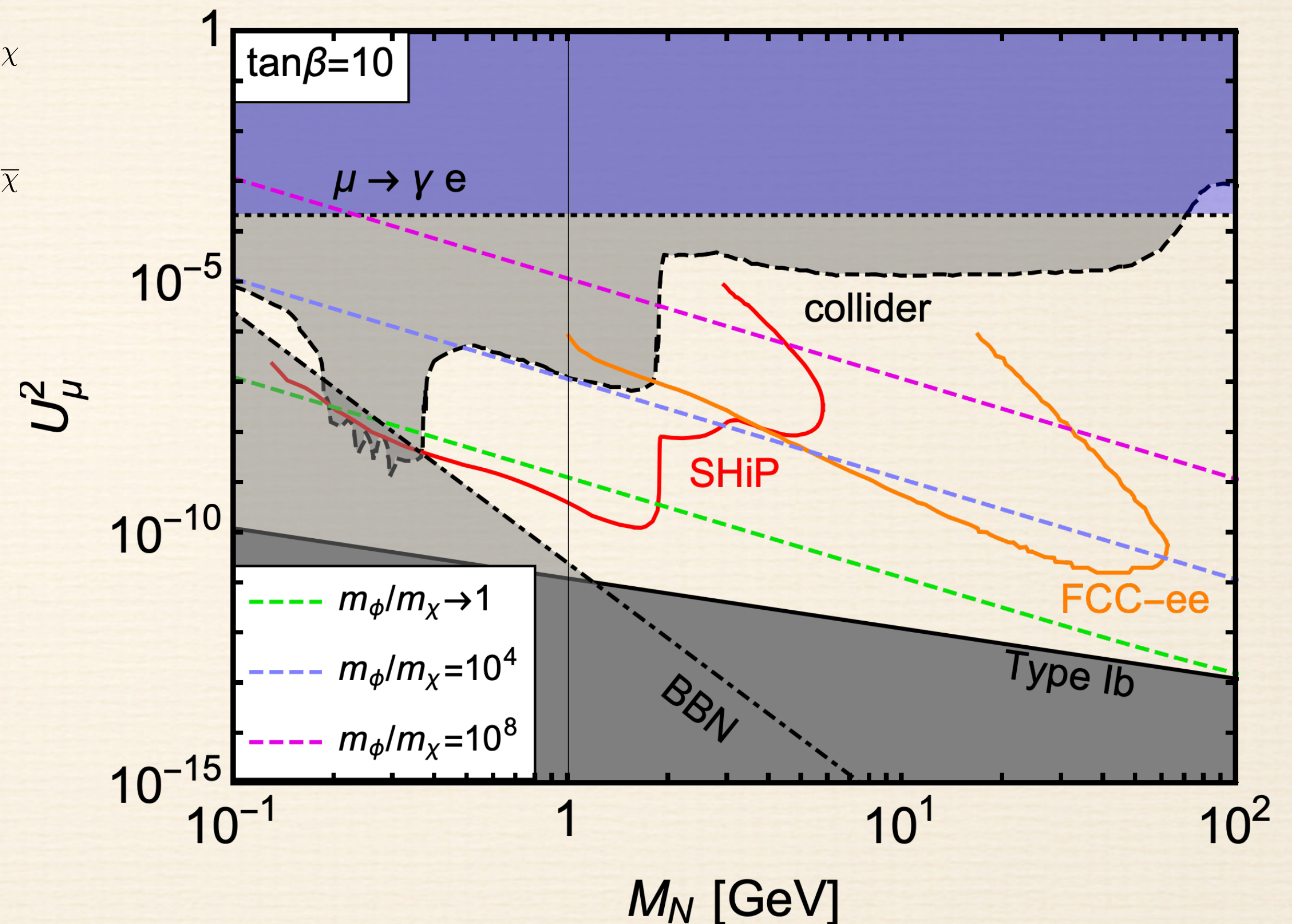
Neutrino portal dark matter

- Neutrino portal dark matter $y\phi\bar{\chi}N$



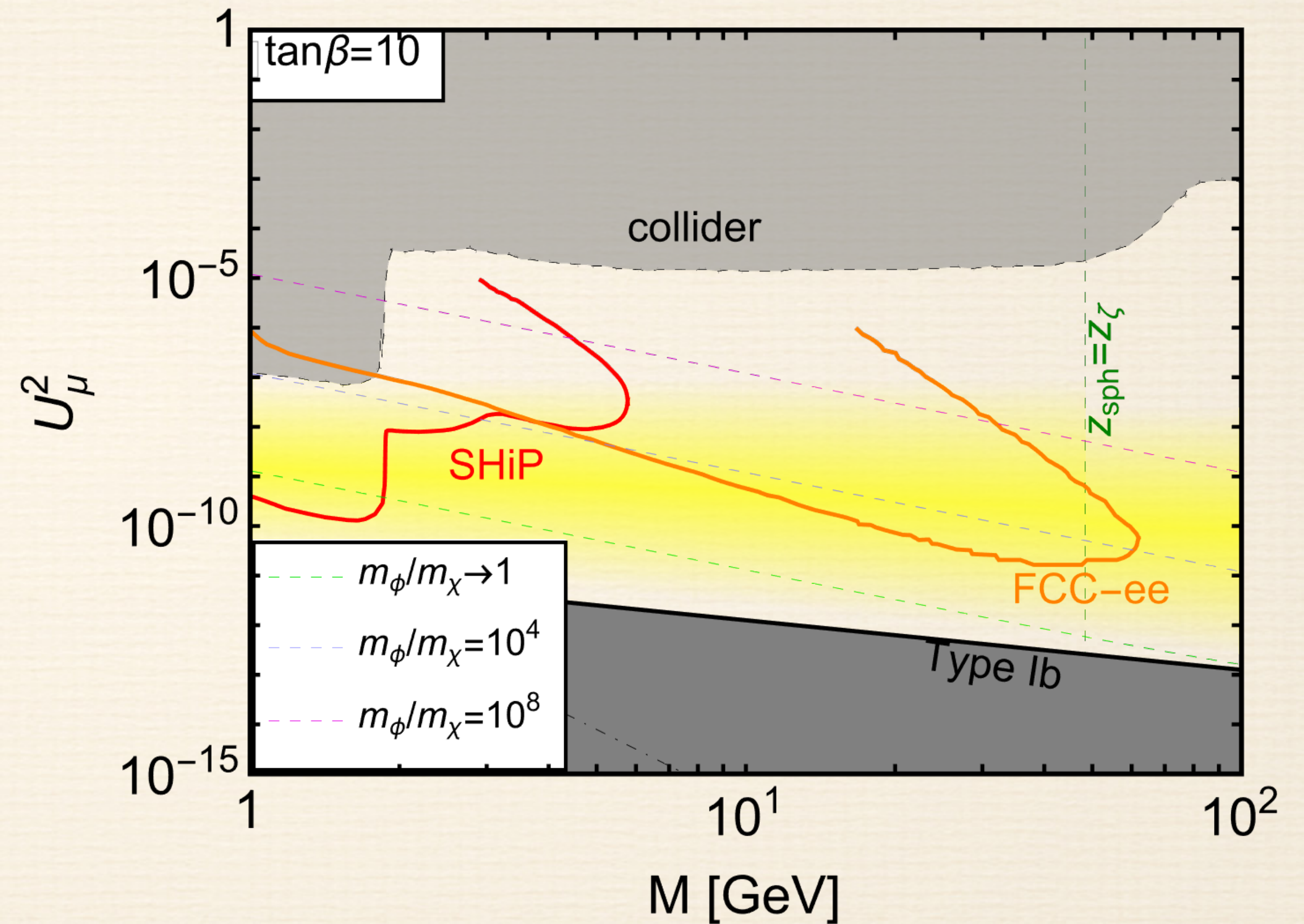
ν -Yukawa process $\propto Y^2 y^2$

- Since one of the seesaw couplings can be large for GeV scale heavy neutrino in the type Ib seesaw mode, the dark matter and neutrino physics can be connected through neutrino portal at GeV scale, which can be further constrained by multiple collider experiment



Resonant leptogenesis

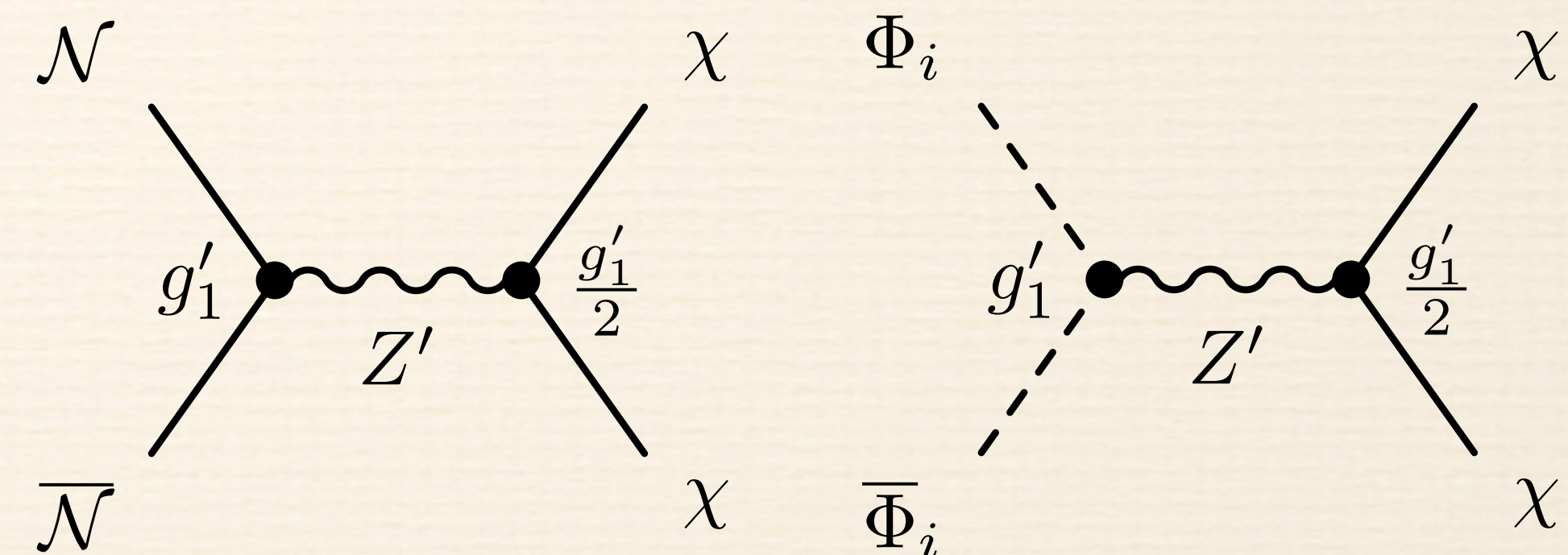
- ❖ CP violation from the Seesaw interactions
- ❖ In an extended model where the type Ib seesaw mechanism can be realised effectively at low energy, baryon asymmetry can be explained by resonant leptogenesis in the parameter space where neutrino physics can be connected to dark matter problem



Vector portal dark matter

- ❖ As the neutrino is Dirac in the type Ib seesaw model, it can be charged under a $U(1)'$ gauge symmetry which can be broken into a Z_2 symmetry that stabilises a Majorana dark matter candidate spontaneously

	$\mathcal{N}$	$\chi_{L,R}$	ϕ
$SU(2)_L$	1	1	1
$U(1)_Y$	0	0	0
$U(1)'$	1	$\frac{1}{2}$	1



Thank You!