III. BMSSM AND SAMPLE POINTS

The above mentioned scenario is hard to be realized in the MSSM. The eigenvalue of the light CP even Higgs is too small (less than 50 or 60 GeV) if CP odd Higgs mass is below 10 GeV in the MSSM. Also the light CP even Higgs usually couples more strongly to Z boson than the heavy one. Therefore, it is not possible to satisfy the direct search bound in the MSSM for such a light CP odd Higgs.

The scenario can be realized in the BMSSM if we include BMSSM operators. If there are new particles at around 1 TeV or higher and if they couple to Higgs fields with order one coupling, we can generate effective dimension five and dimension six operators which can give corrections comparable to the usual D term quartic couplings of Higgs fields. The BMSSM just adds new operators such that they can alter the mass and the couplings of the Higgs fields but does not introduce new light states into which Higgs can decay. Therefore, Higgs decay is modified in the BMSSM only through the modification of Higgs couplings, e.g., $h \to AA$.

There are many operators with effective dimension five and six in the BMSSM. In this Letter, we just consider two of them which might be relevant to the discussion. By including other operators, the whole parameter space would be expanded. Nevertheless, the main feature of the scenario would be the same.

The operators are

$$\begin{aligned} \delta V &= 2\epsilon_1 H_u H_d (H_u^\dagger H_u + H_d^\dagger H_d) + h.c. \\ &\quad + \epsilon_2 (H_u H_d)^2 + h.c. \\ &\quad + \epsilon_3 (H_u^\dagger H_u)^2 + \epsilon_4 H_u H_d (H_u H_d)^\dagger . \end{aligned} \tag{2}$$

ϵ_3 and ϵ_4 are real and ϵ_1 is assumed to be real to simplify the discussion. CP even Higgs mass matrix $\mathcal{M}^2$ is given as follows.

$$\begin{pmatrix} (M_Z^2 + 4v^2\epsilon_2)\cos^2\beta + m_A^2 \sin^2\beta + 4v^2\epsilon_1 \sin 2\beta & (-M_Z^2 - m_A^2 + 2\epsilon_4 v^2)\sin\beta\cos\beta + 4v^2\epsilon_1 \\ (-M_Z^2 - m_A^2 + 2\epsilon_4 v^2)\sin\beta\cos\beta + 4v^2\epsilon_1 & \{M_Z^2 + 2v^2(2\epsilon_2 + \epsilon_3)\}\sin^2\beta + m_A^2\cos^2\beta + 4v^2\epsilon_1 \sin 2\beta \end{pmatrix}.$$

ϵ_1, ϵ_2 and ϵ_4 are the operators that does not exist in the MSSM but can arise in the BMSSM after integrating out massive states at TeV and/or with supersymmetry breaking. ϵ_3 exists