Therefore, to present the gaugino mass relations in the GMSB and AMSB, we only need to calculate a_i in the following.

IV. GAUGE MEDIATED SUPERSYMMETRY BREAKING

First, let us consider the gaugino mass relations and their indices in the GMSB [34]. In the messenger sector, we introduce a set of the SM vector-like particles Φ_j and $\overline{\Phi}_j$. To break supersymmetry, we introduce a chiral superfield X, whose F-term breaks supersymmetry. The messenger fields couple to X via the following superpotential

$$W \supset \lambda_j X \overline{\Phi}_j \Phi_j \ , \tag{96}$$

where λ_i are Yukawa couplings. For simplicity, we assume that the scalar and auxiliary components of X obtain VEVs

$$\langle X \rangle \ = \ M + \theta^2 F \ . \tag{97}$$

Thus, the fermionic components of Φ_j and $\overline{\Phi}_j$ form Dirac fermions with masses $\lambda_j M$. Denoting the superfields and their scalar components of Φ_j and $\overline{\Phi}_j$ in the same symbols, we obtain that their scalar components have the following squared-mass matrix in the basis $(\Phi_j, \ \overline{\Phi}_j^\dagger)$

$$M^2 \ = \ \begin{pmatrix} |\lambda_j M|^2 & -(\lambda_j F)^\dagger \\ -(\lambda_j F) & |\lambda_j M|^2 \end{pmatrix} \ . \tag{98}$$

Therefore, the scalar messenger mass eigenvetors are $(\Phi_j + \overline{\Phi}_j^\dagger)/\sqrt{2}$ and $(\Phi_j - \overline{\Phi}_j^\dagger)/\sqrt{2}$, and the corresponding squared-mass eigenvalues are $(\lambda_j M)^2 \pm \lambda_j F$. The supersymmetry breaking, which is obvious in the messenger spectrum, is communicated to the SM sector via the gauge interactions of Φ_j and $\overline{\Phi}_j$. And then we obtain the gaugino masses at one loop as follows

$$\frac{M_i}{\alpha_i} \ = \ \frac{1}{4\pi} \frac{F}{M} \sum_j n_i(\Phi_j) g(x_j) \ , \tag{99}$$

where $n_i(\Phi_j)$ is the sum of Dynkin indices for the vector-like particles Φ_j and $\overline{\Phi}_j$, $x_j = |F/(\lambda_j M^2)|$, and

$$g(x) \ = \ \frac{1}{x^2} \left[(1+x)\ln(1+x) + (1-x)\ln(1-x) \right] \ . \tag{100}$$