We propose a method for applying the idea of Interference Alignment (IA) in femtocell networks. In order to manage the uplink interference (IM) caused by macrocell users at the femtocell base stations (FBS), cooperation between macrocell users with the closest femtocell base stations could be used to align the received signals of macrocell users in the same subspace at multiple FBS simultaneously. We develop a method to apply IA while providing the QoS requirements of macrocell users, in terms of minimum received SINR at the macrocell base station (MBS). With this approach, the BER performance of femtocell users is shown to improve, while maintaining the quality of the communication channel of macrocell users.

**Femtocell-Macrocell Network Model**

- Two-tier system with different coverage radii
- Two co-existing networks from the same provider
- No prior resource partition
- Each tier serves its own “users”

**Proximity Alignment**

\[
y_k = \sum_{i=1}^{U_k} H_{k1}^i w_k^i s_i + \sum_{j=1}^{F} \sum_{f=1}^{U_f} H_{kj}^f w_k^f s_j + \sum_{m=1}^{M} H_{km} w_m s_m + n_k
\]

**Uplink IM**

- Facilitate a happy medium for BOTH femtocell and macrocell users
- Mitigate (dominant) uplink macrocell interference at Femtocell Base Stations (FBS).
- While doing this, make sure macrocell users (MU) are not disadvantaged.
- Method: Interference alignment (IA) in a two tier system: Aligns the received interference from MU at multiple FBSs simultaneously, while making sure the MU are received properly at their base station (MBS).

**Problem Formulation**

\[
\begin{align*}
\min_{w_1, \ldots, w_M} & \quad \|Hw\| \\
\text{s.t.} & \quad SINR_i \geq \gamma_i \\
& \quad (w^h_i w_i) \leq P_i \quad i = 1, \ldots, M \\
& \quad SINR = \frac{(w^h_i H_{ij} w_j)}{\sum_{j=1}^{M} (w^h_j H_{ij} w_j)} + B + \sigma^2 \\
& \quad B = \sum_{j=1}^{M} (w^h_j H_{ij} w_j)
\end{align*}
\]

**Simulation Results**

- We treat the inter-femto-cell interference as noise
- For interference from within the femto-cell, we consider an MMSE approach.
- Need to ensure the macrocell user interference "stays as aligned as possible".

**IM for the Femtocells**

\[
v_i = \sum_{j=1}^{U_i} (H_{ij}^m w_j^m)^T + \sigma \tilde{n}_i w_i^m
\]

\[
w_i^m = \sum_{j=1}^{U_i} (H_{ij}^m v_j^m)(v_j^m)^T + \mu I\tilde{n}_i w_i^m
\]