Using the commutator of H_0^* with s^+ to bring H_0^* to the left, and using $s^+s^- = s^z + \frac{1}{2} = 1$, we get

$$\frac{J^2}{4\left(E_g + \frac{J}{4}\right)}\left[\frac{H_0^*}{E_g + \frac{J}{4}} + \left(\frac{H_0^*}{E_g + \frac{J}{4}}\right)^2 - \sum_{kk'qq'}\left\{\frac{\epsilon_k - \epsilon_{k'}}{E_g + \frac{J}{4}} + \left(\frac{\epsilon_k - \epsilon_{k'}}{E_g + \frac{J}{4}}\right)^2\right\} c^\dagger_{k\uparrow}c_{k'\downarrow}c^\dagger_{q\downarrow}c_{q'\uparrow}\right] \tag{9.135}$$

The full effective Hamiltonian, for $K = 0$, up to quartic interactions, is

$$H_0^* + \frac{J}{4}\left(\frac{J}{E_g + \frac{J}{4}} - 1\right) - \frac{2V^2}{E_g} - \frac{2V^2}{E_g}\left[\frac{H_0^*}{E_g} + \left(\frac{H_0^*}{E_g}\right)^2\right] + \frac{J^2}{4\left(E_g + \frac{J}{4}\right)}\left[\frac{H_0^*}{E_g + \frac{J}{4}} + \left(\frac{H_0^*}{E_g + \frac{J}{4}}\right)^2\right] + \sum_{kk'qq'} F_{kk'qq'} c^\dagger_{k\uparrow}c_{k'\downarrow}c^\dagger_{q\downarrow}c_{q'\uparrow} \tag{9.136}$$

The coefficient $F_{kk'qq'}$ is

$$F_{kk'qq'} = \frac{V^2}{E_g N^*(E_g + \frac{J}{4})}\left[\frac{V^2}{E_g N^*}\left(\xi_{k'} + 2 - \xi_k\right)\left(\xi_q + \xi_{q'}\right) + \frac{J}{2}\left(\xi_{k'} + 2 - \xi_k + \xi_q + \xi_{q'}\right)\right] - \frac{J^2}{4\left(E_g + \frac{J}{4}\right)}\left[\frac{\epsilon_k - \epsilon_{k'}}{E_g + \frac{J}{4}} + \left(\frac{\epsilon_k - \epsilon_{k'}}{E_g + \frac{J}{4}}\right)^2\right] \tag{9.137}$$

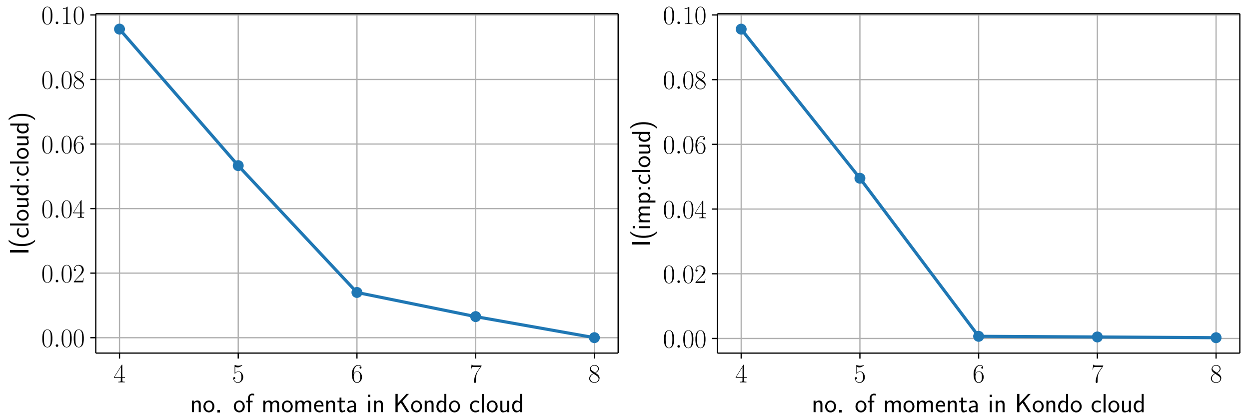

Figure 27: *Left*: Mutual information between two conduction electrons inside the cloud. *Right*: Mutual information between a conduction electron inside the cloud and an impurity electron.

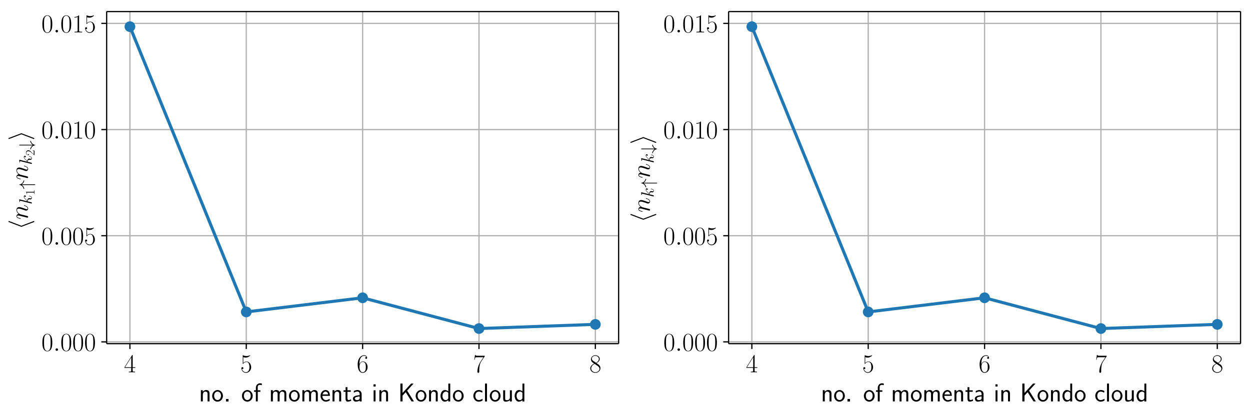

Figure 28: Diagonal correlation functions between cloud electrons

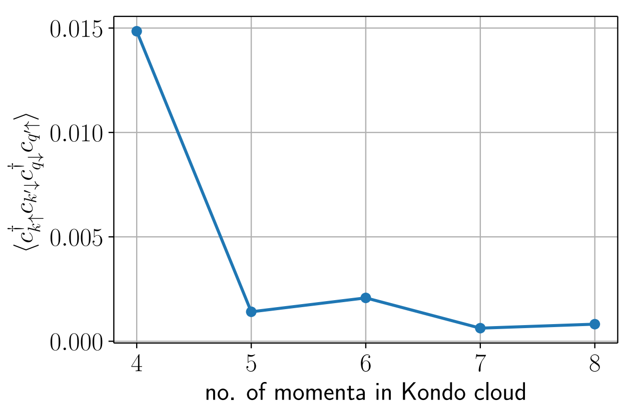

Figure 29: off-diagonal correlation function