Repulsive Fermi polarons in a resonant Fermi-Fermi mixture

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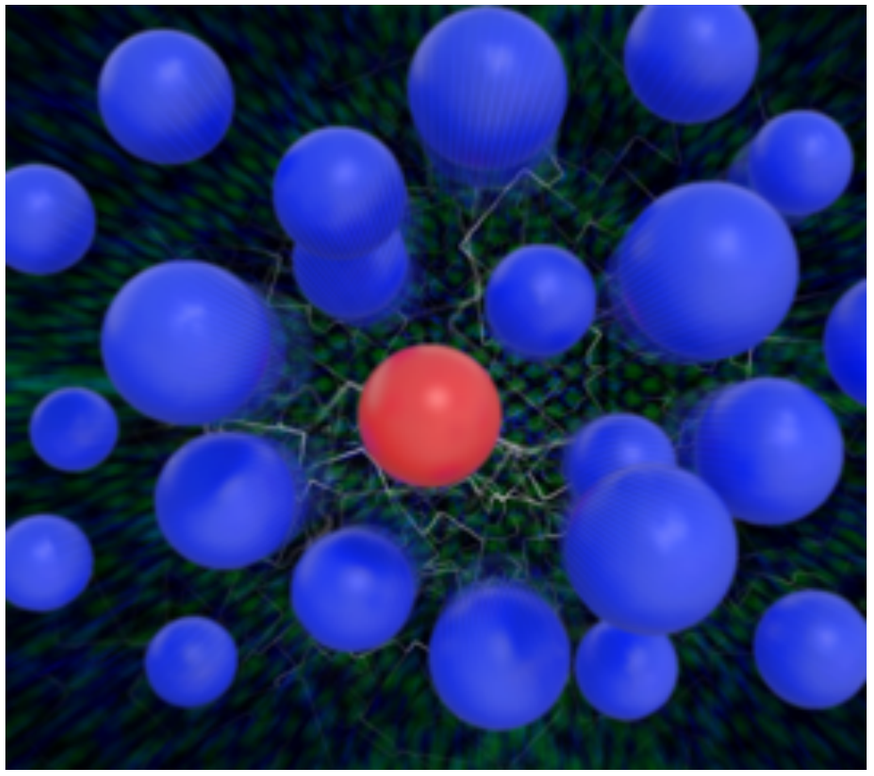

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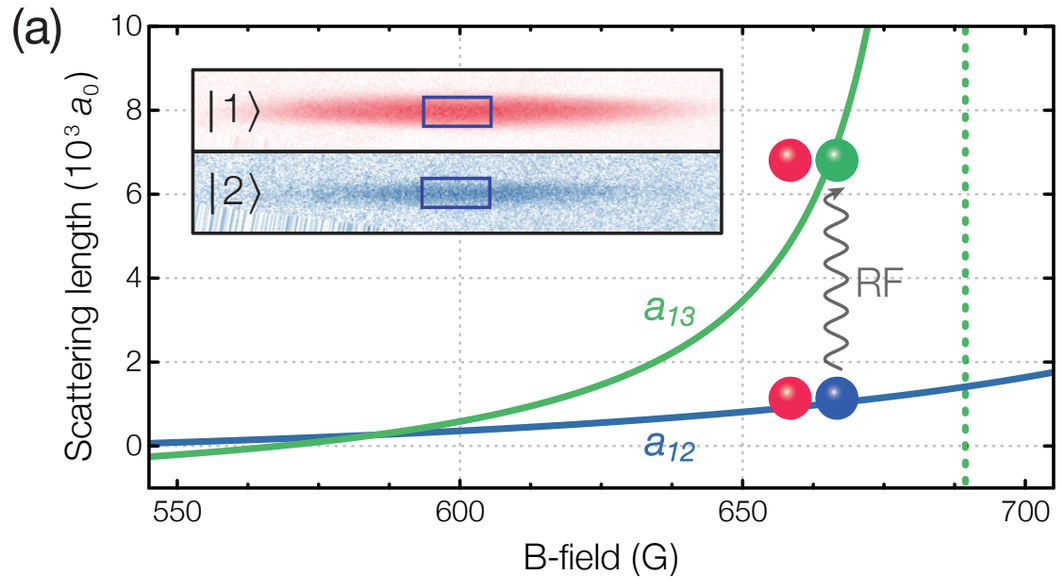
SUGGESTION

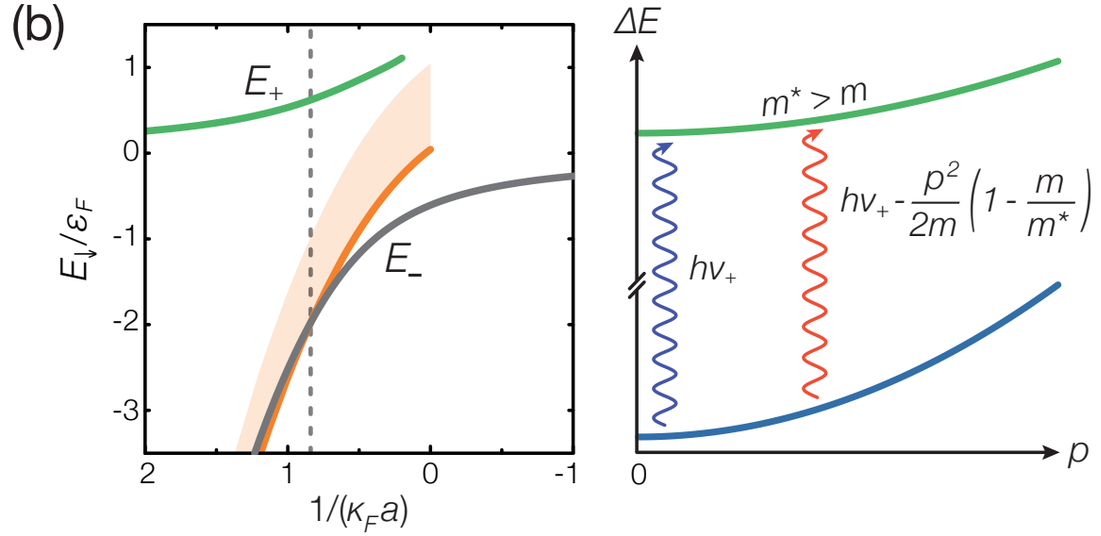
Inverse RF spectroscopy



repulsive polaron

dressed dimer

attractive polaron



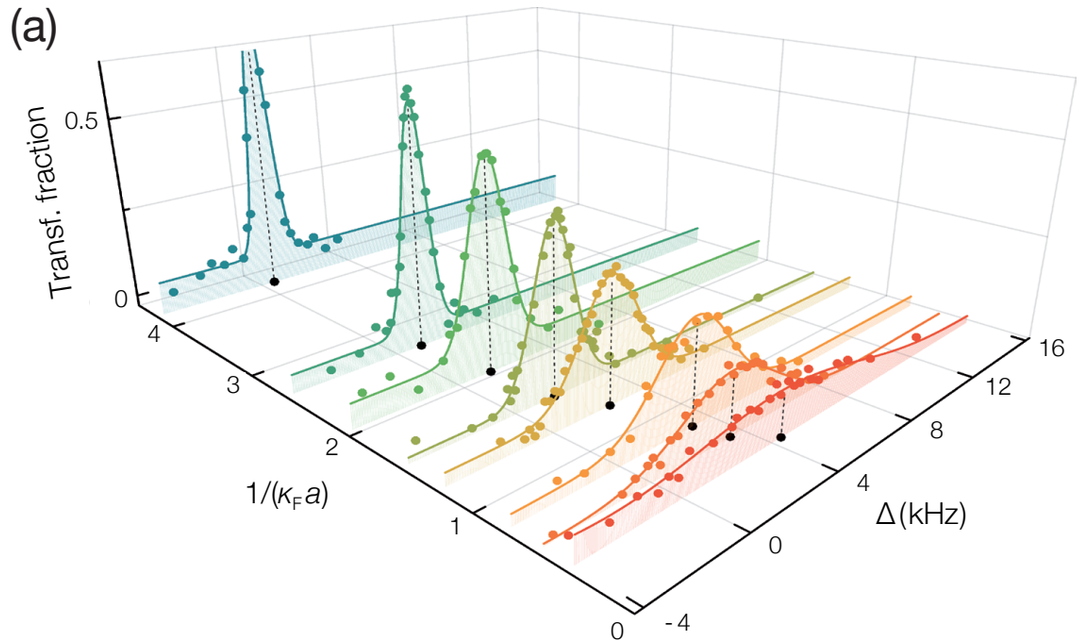
dressed impurity

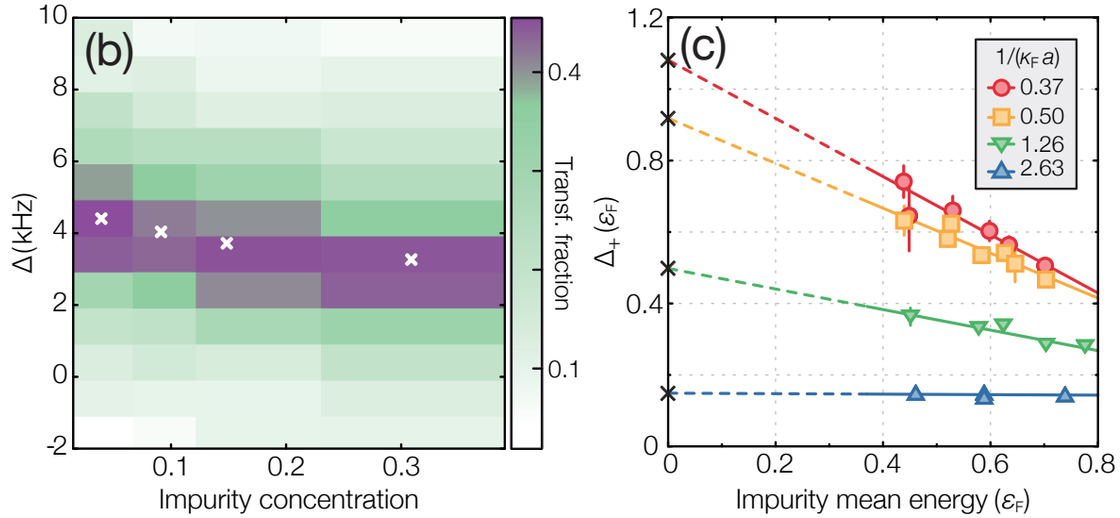
bare impurity

(a) Scattering properties of the initial (1-2) and final (1-3) mixtures.
Inset: *In situ* absorption images of 1 (red) and 2 (blue) atomic clouds for $x=N_\downarrow/N_\uparrow=0.1$.

(b) Left: Energy $E_\downarrow$ of a zero-momentum impurity in a Femi sea.
Vertical dashed line: polaron/molecule crossing.
Right: momentum dependence of the impurity resonance frequency.

Repulsive polaron spectra





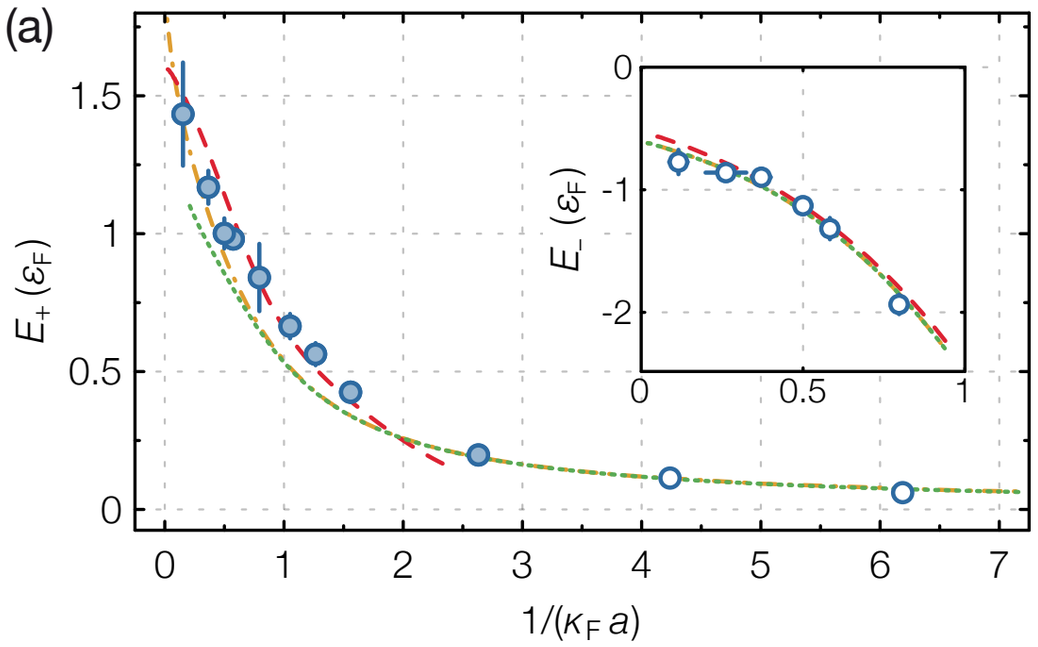
$$\Delta_+ = E_+ - (1 - \frac{m}{m^*})\,\omega$$

Repulsive polaron spectra
(a) at different $1/k_F a$ values with impurity concentration x=0.15
(b) at different concentrations with $k_F a \simeq 2$.

(c) Resonance position Δ_+ vs impurity's mean energy for various $1/k_F a$ values.

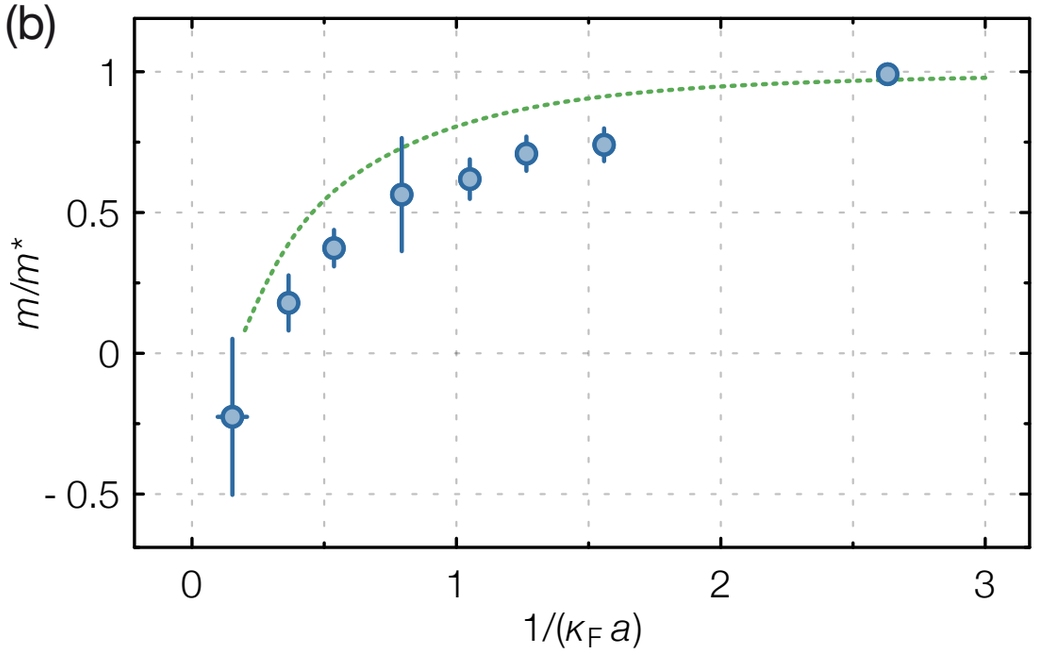
Energy and effective mass

energy of the repulsive polaron



energy of the attractive polaron

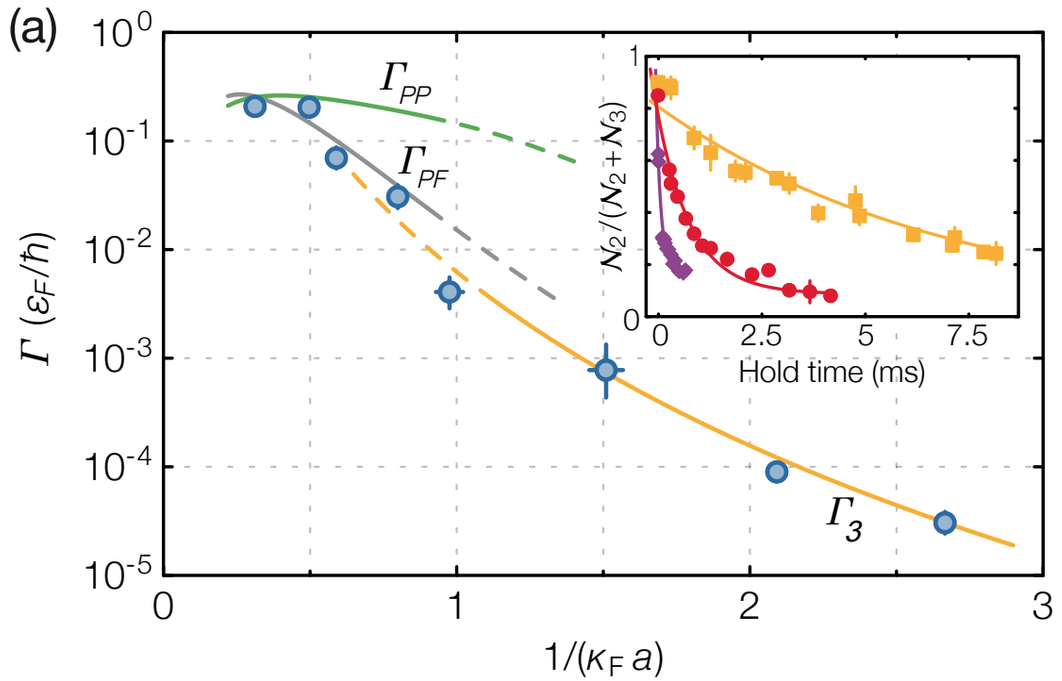
(inverse) effective mass of the repulsive polaron



Theory:
Cui & Zhai, PRA 2010
Massignan & Bruun, EPJD 2011
Schmidt & Enss, PRA 2011

Decay rate and coherence

decay rate of the repulsive polaron

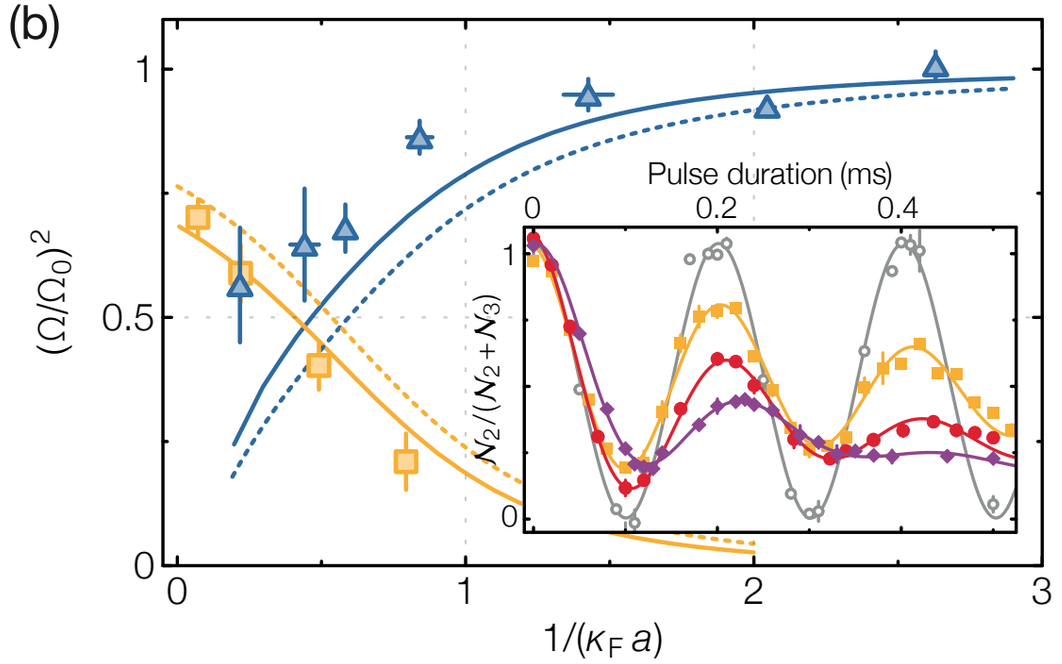


dynamics of population decay

Theory:
Petrov, PRA 2003
Massignan & Bruun, EPJD 201
this paper

frequency of the Rabi oscillations (attractive and repulsive)

residue: $Z = |\Omega/\Omega_0|^2$



$k_F a \sim$ 0, 1.1, 1.3, 1.7

Theory

impurity Green's function:

$$G_\downarrow(\mathbf{p},\omega) = \frac{1}{\omega - \xi_{\mathbf{p}\downarrow} - \Sigma(\mathbf{p},\omega) + i0^+} \approx \frac{Z_\pm}{\omega - E_\pm - \frac{p^2}{2m^*_\pm} + i\Gamma_\pm/2}$$

eq. of state:

$$\frac{E - \frac{3}{5}E_F N_\uparrow}{N_\downarrow} = E_\pm + \frac{3}{5}E_F \frac{m}{m^*_\pm} x^{2/3} + \frac{3}{5}E_F F_\pm x$$

self-energy: (T-matrix approx.)

$$\Sigma(\mathbf{p},\omega) = \sum_{\mathbf{q}} f(\xi_{\mathbf{q}\uparrow})\, T(\mathbf{p}+\mathbf{q}, \omega + \xi_{\mathbf{q}\uparrow})$$

$$= \sum_{\mathbf{q}} \frac{f(\xi_{\mathbf{q}\uparrow})}{\frac{m_r}{2\pi a} - \sum_{\mathbf{k}} \left[\frac{1-f(\xi_{\mathbf{k}\uparrow})}{\omega - (\varepsilon_{\mathbf{p}+\mathbf{q}-\mathbf{k}\downarrow} + \varepsilon_{k\uparrow} - \varepsilon_{q\uparrow}) + i0_+} + \frac{2m_r}{k^2} \right]}$$

decay rate:

$$\Gamma_\pm = -2Z_\pm \mathrm{Im}[\Sigma(\mathbf{p}, E_{\downarrow\pm})]$$