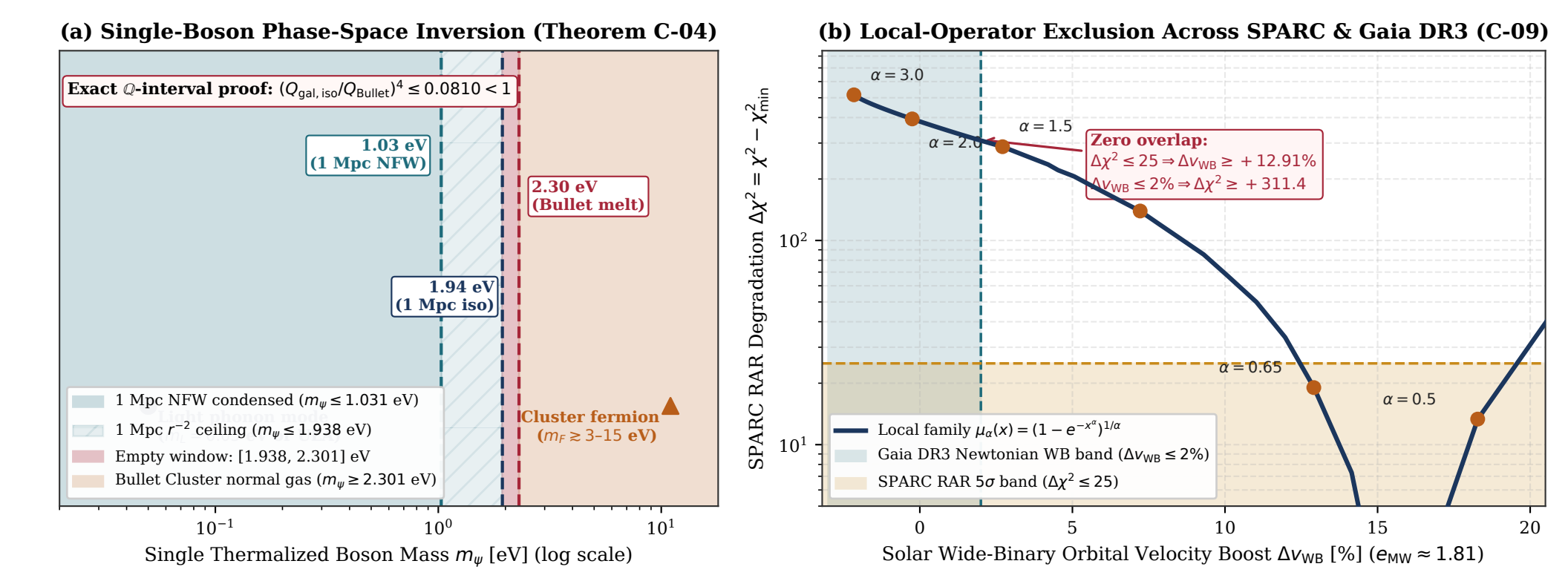

(a) Single-Boson Phase-Space Inversion (Theorem C-04)
Exact 𝒬-interval proof: $(Q_{\mathrm{gal,\,iso}}/Q_{\mathrm{Bullet}})^4 \le 0.0810 < 1$
1.03 eV
(1 Mpc NFW)
2.30 eV
(Bullet melt)
1.94 eV
(1 Mpc iso)
Cluster fermion
($m_F \gtrsim$ 3–15 eV)
1 Mpc NFW condensed ($m_\psi \le 1.031$ eV)
1 Mpc r^{-2} ceiling ($m_\psi \le 1.938$ eV)
Empty window: [1.938, 2.301] eV
Bullet Cluster normal gas ($m_\psi \ge 2.301$ eV)
10^{-1}
10^{0}
10^{1}
Single Thermalized Boson Mass m_ψ [eV] (log scale)
(b) Local-Operator Exclusion Across SPARC & Gaia DR3 (C-09)
SPARC RAR Degradation $\Delta\chi^2 = \chi^2 - \chi^2_{\min}$
10^{2}
10^{1}
$\alpha = 3.0$
$\alpha = 2.0$
$\alpha = 1.5$
Zero overlap:
$\Delta\chi^2 \le 25 \Rightarrow \Delta v_{\mathrm{WB}} \ge +12.91\%$
$\Delta v_{\mathrm{WB}} \le 2\% \Rightarrow \Delta\chi^2 \ge +311.4$
$\alpha = 0.65$
$\alpha = 0.5$
Local family $\mu_\alpha(x) = (1 - e^{-x^\alpha})^{1/\alpha}$
Gaia DR3 Newtonian WB band ($\Delta v_{\mathrm{WB}} \le 2\%$)
SPARC RAR 5σ band ($\Delta\chi^2 \le 25$)
0
5
10
15
20
Solar Wide-Binary Orbital Velocity Boost Δv_{WB} [%] ($e_{\mathrm{MW}} \approx 1.81$)