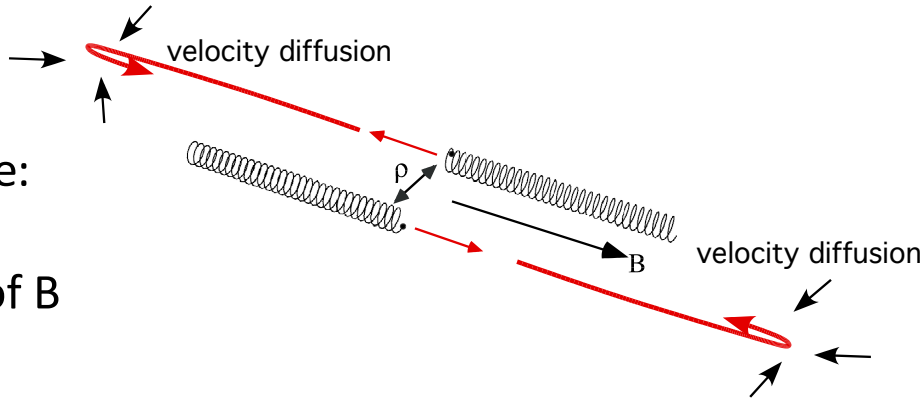
Novel effects in Slowing due to Long Range Collisions

The UCSD group has developed wide-ranging theory and experiments describing transport from long range collisions with impact parameter ρ larger than the cyclotron radius r_c

These collisions are in addition to the standard short-range collisions with $b<\rho<r_c$



In nonneutral plasmas the long range collisions cause:

- Cross-field diffusion enhanced by 10x
- Heat transport enhanced by 100x, independent of B
- Viscosity enhanced by 10^5x, increasing with B

We have now shown that long range collisions also can strongly enhance collisional slowing ν_s

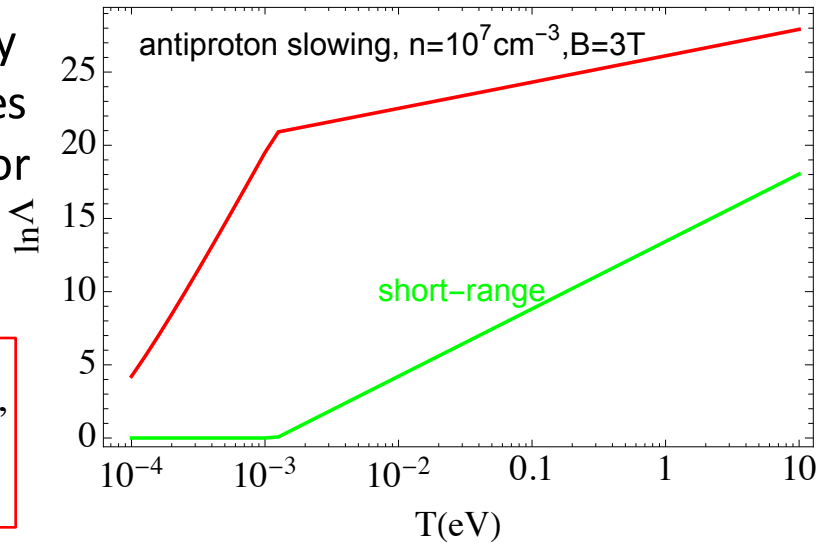
D. Dubin, Phys. Plas. 21, 052108 (2014); M Affolter et. Al, Phys. Rev. Lett. **117**, 155001 (2016)

A new fundamental length scale d was identified: $d = b\left(\bar{v}^2 / b^2\nu_s^2\right)^{1/5}$ $b = e^2/T$, $\bar{v} = \sqrt{T/m}$

For $\rho<d$: long range collisions are two-body and point-like; particles either reflect or pass by

For $\rho>d$: multiple weak collisions occur simultaneously; particles diffuse in velocity

The short range Coulomb logarithm (green) is enhanced by two new terms from long-range collisions (red). This applies to Penning trap plasmas for both matter and antimatter, for some astrophysical plasmas, and even for the edge region of tokomak plasmas.



$$\nu_s = \sqrt{\pi} n \bar{v} b^2 \ln\Lambda; \text{ where } \ln\Lambda = \left\{ h\ln(d/r_c) + 2\ln(\lambda_D/d) + \frac{4}{3}\ln(r_c/b) \right\},$$

$h = 5.899$ for repulsive collisions; $h = 0$ for attractive collisions