Energetic Particle Transport in Optimized Stellarators

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Motivation
- Alpha particle confinement is a key issue for stellarators
- It is often difficult to compare between configurations
- What features and proxies are best predictive of good energetic particle confinement?

Configurations
- Configurations scaled to have ARIES-CS volume (450 m³ and field (5.7 T)
- 3 QHs, 3 QAs, 1 QO (W7-X), 2 Heliotrons (LHD) and 1 Tokamak (ITER) are scaled and compared

Collisional Calculations
- When collisions added, QHs still perform well, but not as well compared to other configurations
- Wistell-A, LHD-inward, and W7-X all perform nearly equally with collisions
- ITER outperforms best QHs but only by a small margin
- Metric analysis shows collisional energy loss is correlated with \( \Gamma \) and (less so) with quasisymmetry

Conclusions
- LHD-inward, W7-X, and Wistell-A all perform similarly in collisional calculations but differently in collisionless results:
  - LHD: no prompt losses, all particles lost eventually, but slowly (improves relatively with collisions)
  - Wistell-A: some prompt losses, occur near trapped passing boundary where diffusion is high (losses increase with collisions)
  - W7-X: some prompt losses, occur in deeply trapped regions where diffusion is low (losses do not increase with collision)
- LHD inward-shifted configuration has smoothly varying field along a field line and alignment of minima
- Prompt losses are dangerous for plasma facing components
- Slower losses are often tolerable
- Heating profiles may differ (future work)

References
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