SHORT HW 3: Cross Sections

Cross Section Limits

Cross section measure the likelihood of a specific scattering process. In this problem, we try to build some intuition for the meaning of a cross section by drawing on classical physics. For this problem, the scattering is assumed to mean *any kind of deflection of the probe relative to its motion if the target were not there.*

1 Geometric Cross Section

Suppose you are shooting tiny pellets at a billiard ball. What is the approximate classical cross section of the billiard ball? For this problem you can use human-scale units like centimeters. Write a formula and give an order of magnitude answer with units.

2 Charged Billiard Ball with Charged Probe

Now suppose the tiny pellets had a small positive charge and the billiard ball had a small negative charge. Does the cross section go up, down, or stay the same?

3 Charged Billiard Ball with Charged Probe, Too

Same as the previous question, but now both the pellets and the billiard ball have positive charge. Does the cross section go up, down, or stay the same relative to the uncharged case? Does the cross section go up, down, or stay the same relative to the opposite-charge case?

4 Cross section for a long-range force

No calculation necessary[1]. What is the cross section for an electron to scatter off a proton? The answer may cause you to pause, if it looks unusual, explain what it means.

COMMENT: This question is a little tricky, if you are confused then articulate why you are confused and we can talk about it on Thursday! Do *not* spend more than 30 minutes on this problem, you are *not* meant to (re-)derive the classical central potential cross section.

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[1]You do not have to do a calculation, but you may want to refer back to the discussion of scattering in classical mechanics to remind yourself of what's going on here.