

# Measuring $\bar{n}$ , $\bar{p}$ Reflections

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# Coherent Reflections

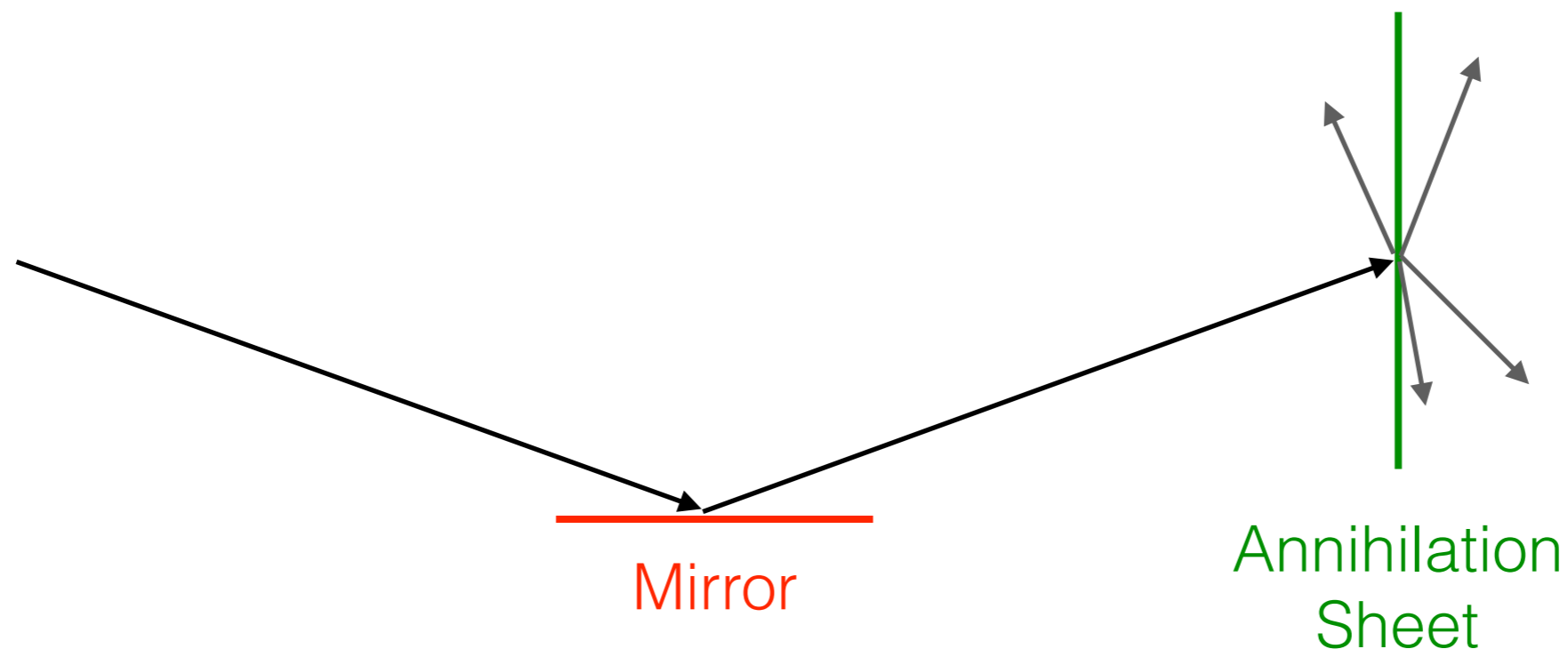
- Two papers argue neutrons can be reflected without resetting the oscillation clock
  - Kerbikov [arXiv:1810.02153](https://arxiv.org/abs/1810.02153)
  - Nesvizhevsky, Gudkov, Protasov, Snow, Voronin [arXiv:1810.04988](https://arxiv.org/abs/1810.04988)
- If correct, we can make the detector far more compact + increase sensitivity (potentially by a lot)
- Can we verify this experimentally?
  - OBELIX did observe reflected antiprotons [arXiv:0802.2893](https://arxiv.org/abs/0802.2893)
    - Experiment done at LEAR, 1986-1996
    - Also measured antineutron-proton cross-sections
      - Antineutron beam produced via charge exchange,  $\sim 3 \cdot 10^{-5}$  (50-400 MeV) antineutrons per 400 MeV antiproton

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- If correct, we can make the detector far more compact + increase sensitivity
- Can we verify this experimentally?
  - Need low energy anti-neutrons (or anti-protons)
  - CERN Antiproton Decelerator:
    - Cools antiprotons down to 5.3 MeV, followed by ELENA to further cool to 100 keV
      - ELENA designed to deliver  $10^7$  antiprotons every 110s
    - Currently two experiments, AEGIS and GBAR, both to measure gravitational pull on anti-hydrogen
      - GBAR further decelerates antiprotons to 1 keV
  - (Currently starting discussion about AD operation after 2025)

# Measurement?

- What would we measure?
  - antineutron and antiproton reflection coefficient and annihilation cross-section as a function of  $p_T$  wrt the mirror(s)
    - Including with polarized anti-nucleons? Then also need to measure outgoing polarization
- How?
  - Effectively want an NNbar-like detector
    - Can reconstruct anti-neutron momentum from annihilation products



# Moving forward

- When agree on measurement to make, go talk to AD people (start with Michael Doser I think)
- Effort: could form nice thesis topic(s)
  - Help design and build experiment
  - Take data
  - Analyze and publish

} in ~5 years?
- BTW: part of this community may be looking for new things in ~5 years
  - Upgrade path for anti-hydrogen physics not clear
  - Maybe they could be interested in joining our effort
    - Substantial expertise in low energy antimatter physics