Measuring the optical scattering in n-type GaAs that could explain its high cryogenic scintillation luminosity

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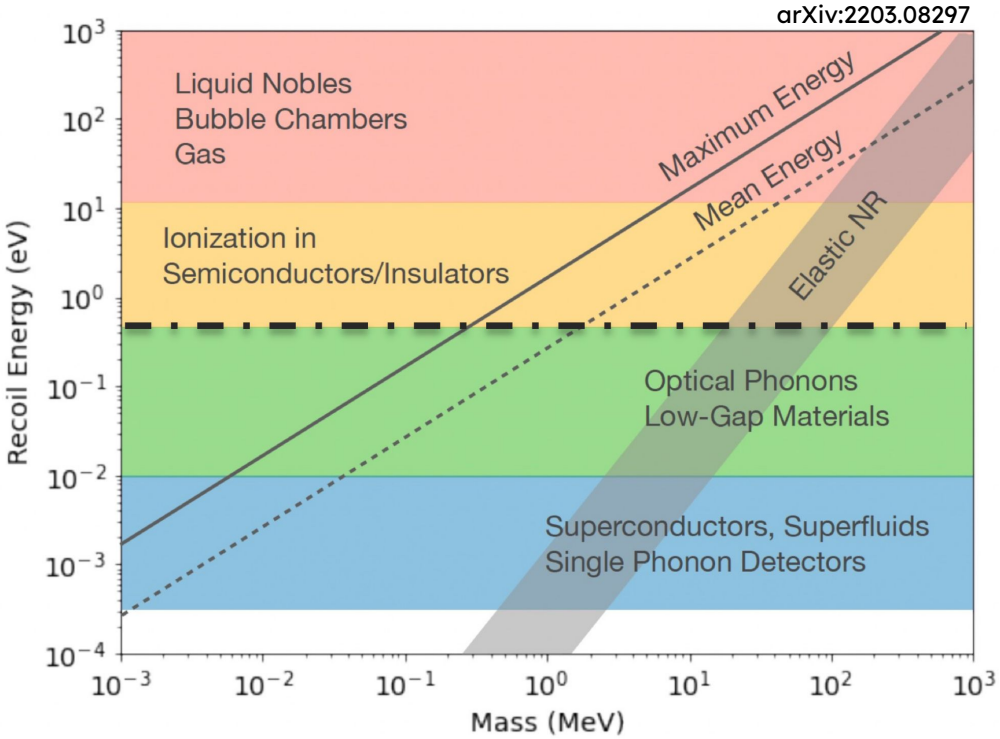
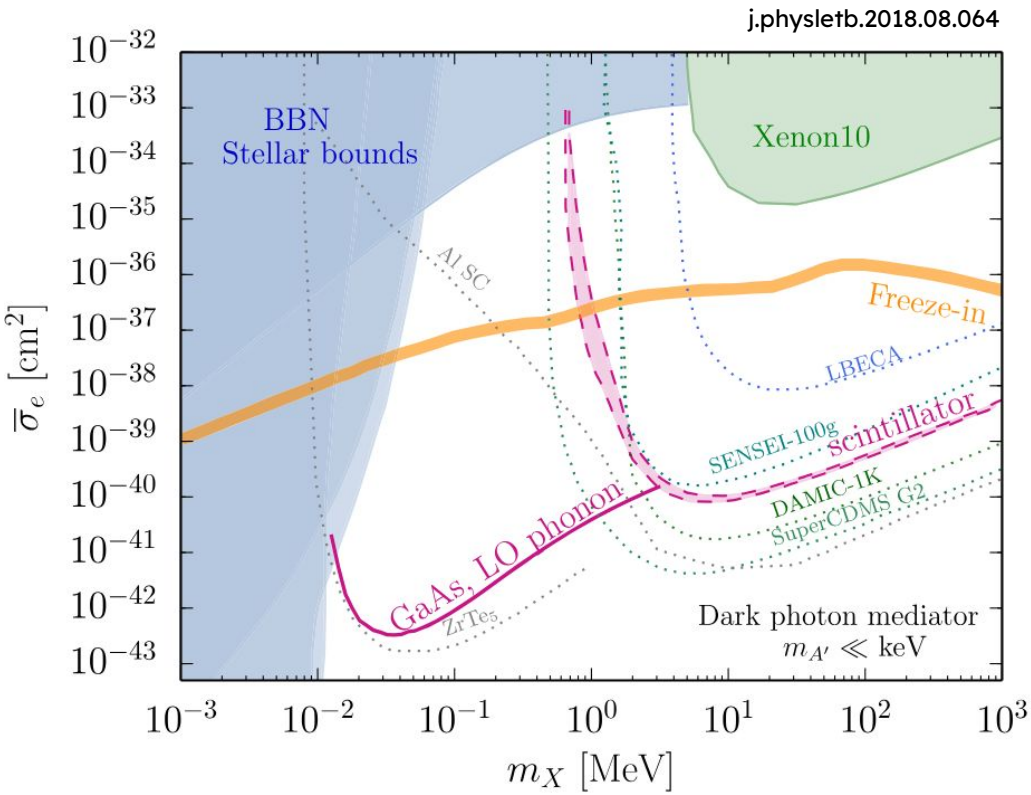
The New frontiers in Dark Matter Searches



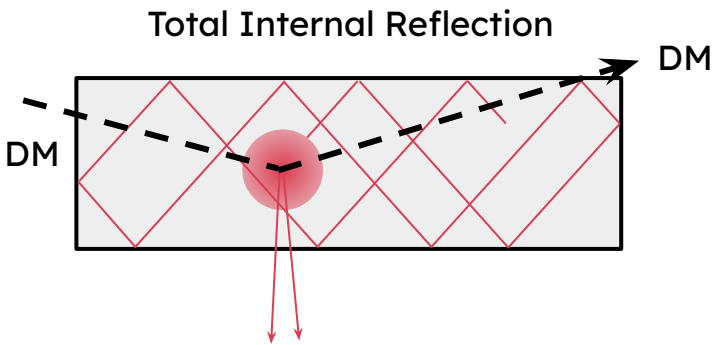
- Elastic NR searches are limited in M_{DM} for the low recoil energy
- Phonons and Coherent response of electrons reduce the lower threshold

The Cool Novel DM Targets



- **Cryogenic targets** show great performances for light dark matter detection sensitivities
- **GaAs** is promising given its low band-gap, **scintillation** properties and purity

The Dope side of GaAs



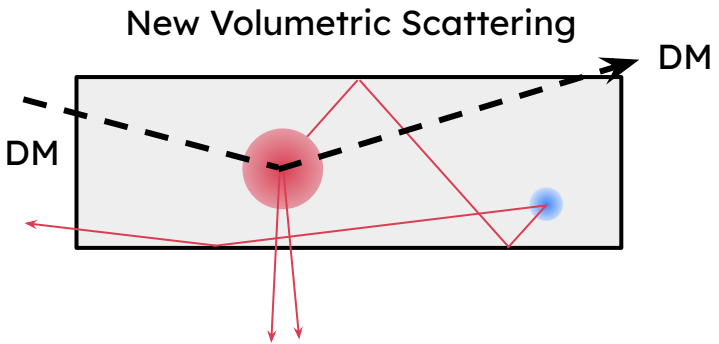
- N-type GaAs is incredibly bright!
- However, given the high probability (~90%) of photon trapping due to total internal reflection,
- a volumetric scattering process, randomizing the photon direction with no wavelength shift, is needed to explain its brightness

Light Scattering Processes

	Wavelength limited	Low cross section	Wavelength shift
Thomson	NO	YES	NO
Rayleigh	NO	YES	NO
Mie	YES	NO	NO
Raman	NO	YES	YES

Hypothesis on GaAs Brightness Nature

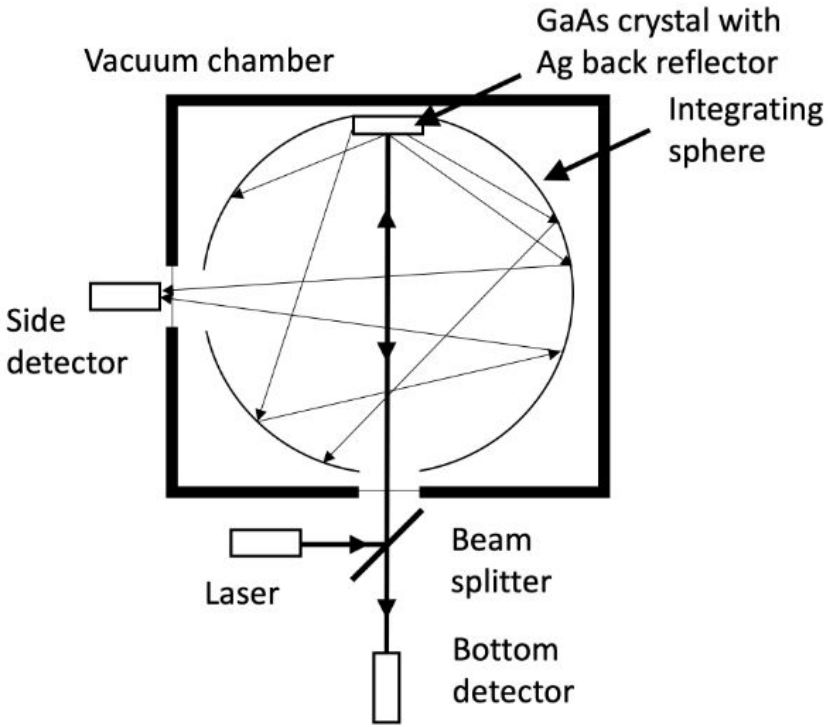
- A new volumetric scattering phenomenon is proposed:
  - Randomization of photon direction
  - No wavelength shift
  - High cross-section



- We aim to confirm this volumetric scattering hypothesis by comparing measurements of scattered light with optical simulations.

Test on the Hypothesis on GaAs Brightness Nature

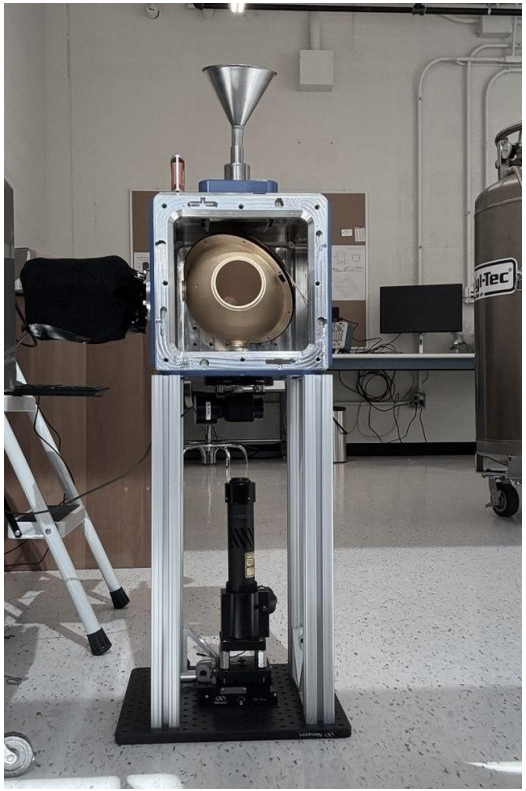
- We exploit a narrow IR beam and two detectors sensitive to detect IR wavelengths
- The laser beam hits the GaAs target, back-coated with Ag, and diffused and transmitted light are measured



- We want to prove that the high luminosity can occur since most of the narrow beam absorption is due to scattering and only in little part to internal absorption

The experimental set-up

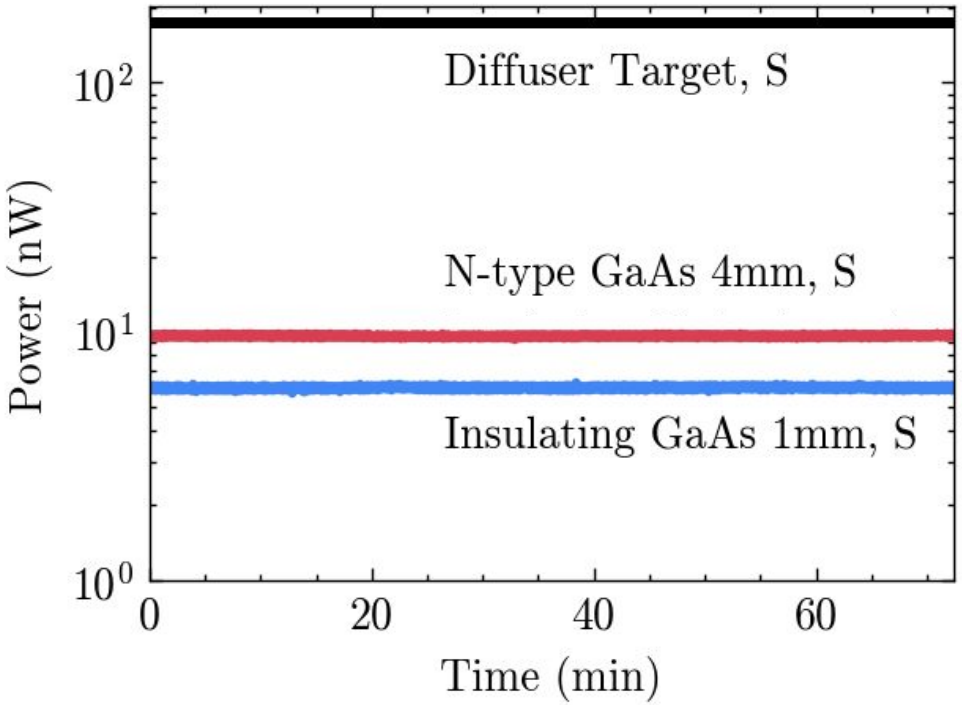
- Precise alignment of returning laser beam and B detector provided by linear stages
- Vacuum pump for target cool down
- Temperature sensors to track target cool down
- Fan to prevent water condensation on window ports



First Results

- For systematic and background mitigations we exploit several targets

- The first measurements of n-type GaAs diffused IR light are promising, showing an enhancement with respect to undoped GaAs crystal



Summary and Outlook

- First measurements of diffused light from different targets
- Noise hunting and mitigation of systematics sources will be carried out in the next weeks
- LN cold temperature measurements planned to track the expected enhancement of the N-type GaAs diffused light
- Spectrometer measurements to confirm there is no photon wavelength shift

Thank you!
Questions?