

Meera Patel

Cover Letter For Prof. Dr. Björn Penning Cryogenic Dark Matter Search Position at University of Zurich

Dear Dr. Penning,

I am writing to apply for the PhD position in cryogenic dark matter searches within your group at the University of Zurich. I am completing my Master's in Physics and Astronomy at the University of Amsterdam, with my thesis at Nikhef on detector R&D for liquid noble gas experiments under Dr. Tina Pollmann. I have spent the past year doing hands-on lab work on the VULCAN experiment, including designing hardware, building and debugging vacuum setups, and developing analysis tools, and this sort of instrumentation driven research is the kind of work I want to continue into a PhD and beyond in my academic career.

My thesis work connects directly to the challenges of this position. VULCAN measures photoluminescence properties of wavelength-shifting materials at VUV wavelengths for noble gas TPCs, and I contribute on both the hardware and analysis sides. I have designed a new SiPM cooling system to suppress dark count rates, am installing an optical chopper for time-resolved decay measurements, and have refactored the data processing pipeline with matched filtering to recover sensitivity lost to noise. This last point feels particularly relevant to cryogenic rare event searches; the TESSERACT collaboration's recent identification of spontaneous phonon bursts from bulk silicon as a dominant source of both above-threshold backgrounds and sub-threshold excess noise shows that understanding and mitigating noise at the lowest energy scales is central to pushing sensitivity. My experience extracting signals from noisy detector data, and building the hardware improvements that reduce that noise at the source, is the kind of work I want to bring to superconducting sensor development and cryogenic data analysis. I also received the Olga Igonkina Foundation Travel Grant to conduct VUV measurements in a liquid argon setup at AstroCENT in Poland, and I have been supervising a bachelor's student on the VULCAN project. This experience of taking initiative to design and execute improvements on my own, while contributing to the group through supervision and collaboration, is something I look forward to continuing in a PhD.

What draws me to this position specifically is the physics case for exploring the light dark matter mass range. As WIMP-scale cross sections become increasingly constrained and pushing into the neutrino fog, I think the most compelling frontier is at lower masses, where coherent elastic neutrino-nucleus scattering forms an irreducible background and different detection strategies are needed. TESSERACT's multi-target approach with superconducting quantum sensors opens sensitivity to DM interaction channels that liquid xenon experiments simply cannot access, and the QROCODILE results demonstrate that SNSPDs can already set significant constraints on sub-MeV dark matter with directional sensitivity built into the detector geometry. I do not have direct experience with superconducting sensors or dilution refrigerators, but developing expertise in these technologies is what I want from a PhD, and my background in detector hardware, cryogenic cooling, and low-level signal analysis gives me a concrete foundation to build on. The group's simultaneous involvement in LZ and XLZD also connects well with my existing work within the liquid xenon dark matter program through Nikhef.

Thank you for considering my application. I look forward to the possibility of contributing to your group's research.

Sincerely,
Meera Patel