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#### Parallel plate force metrology as a tool to probe TECHNISCHE UNIVERSITÄT vacuum energy and the dark sector WIEN WIEN

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#### Precision force measurements give some of the tightest limits Abstract:

- on hypothetical dark energy and dark matter interactions, including the QCD axion.
- Currently, there is a sensitivity gap between Casimir experiments and torsion balance measurements (3–30 μm).
- The Casimir And Non-Newtonian force EXperiment (CANNEX) is the worldwide only metrological force experiment implementing the geometry of **plane parallel plates**.
- > This geometry maximizes the generated force and sensitivity for interfacial forces, such as the Casimir effect, while at the same time allowing competitive measurements of volumetric interactions, such as gravity.
- > Here, we present the **proof of principle**, an updated design, and prospective results of this experiment.

# Why a *classical* setup is still competitive in times of *quantum* experiments:

- Amplification factor for force generation: 10<sup>23</sup>
- Systematic errors can be controlled and quantified very well
- Ideal ge++ometry allows closed-form solutions for many theories and eases experiment/theory comparison.



- Clear distinction between all dielectric models at all separations
- ► First quantitative measurement of non-equilibrium effect [Klimchitskaya2019]
- New scalar-pseudoscalar limits possible (not shown, [Klimchitskaya2019b])

### References:

Adelberger et al., Prog. Part. Nucl. Phys. 62, 102 (2009) Jaffe et al., Nat. Phys. 13, 938 (2017) Almasi et al. Phys. Rev. D 91, 102002 (2015) Chen et al., Phys. Rev. Lett. 16, 221102 (2016) Geraci et al., Phys. Rev. D 78, 022002 (2008) Hamilton, et al., Science **349**, 849 (2015)

Kapner et al. Phys. Rev. Lett. 98, 021101 (2007) Klimchitskaya et al. Phys. Rev. A **100**, 022511 (2019) Klimchitskaya et al. Symmetry 11, 407 (2019) [b]

Sabulskiy et al. Phys. Rev. Lett. 123, 061102 (2019) Jenke et al., Eur. Phys. J. Spec. Top. 230, 1131 (2021) Sedmik and Brax, J. Phys. Conf. Ser. 1138, 012014 (2018) Sedmik and Pitschmann, Universe 7, 234 (2021) Tan et al. Phys. Rev. Lett. **124**, 051301 (2020) Upadhye et al. Phys. Rev. Lett. **110**, 031301 (2013)

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# Collaboration

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