Slow beam and nanograting : accurate measurement of Casimir-Polder Interactions

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The Casimir-Polder potential represent the interaction between an atom and a surface. One can use different approximation depending on the distance of the atom from the surface.

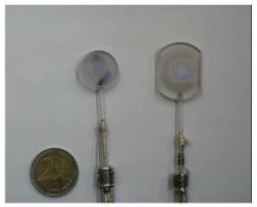
$V_{Casimir-Polder}(z)$

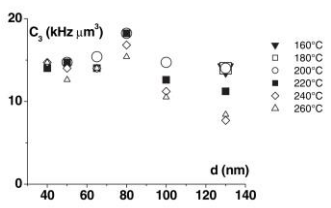
Non Retarded (Van der Waals)	Intermediate (Wylie & Sipe)	Retarded (Casimir)
$V_{vdW}(z) = -\frac{C_3}{z^3}$	$V_{W\&S}(z) = -\frac{C_3(z)}{z^3}$	$V_{Casimir}(z) = -\frac{C_3}{z^3}$

z

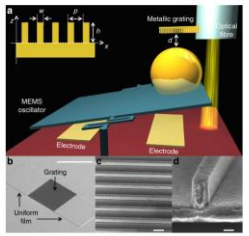
$z \propto 20\ nm$

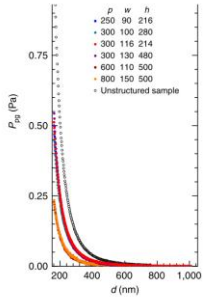
$z \propto 1\ \mu m$



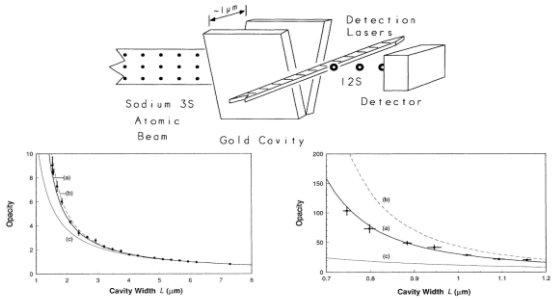


Bloch, Ducloy LPL, 1990





F. Intraviaet al. Nature 2013

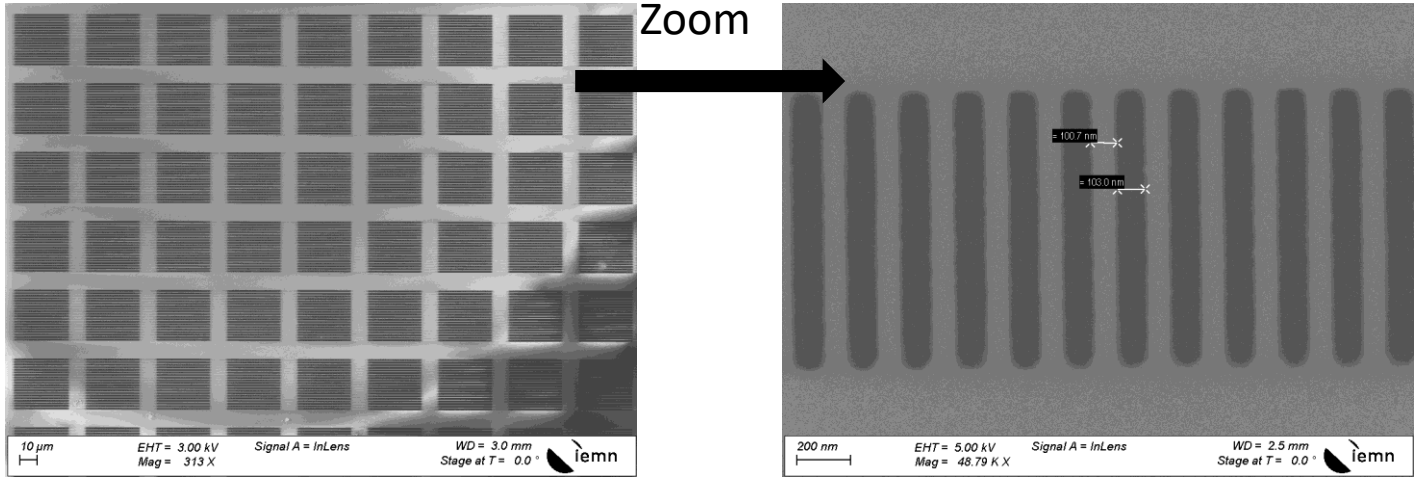


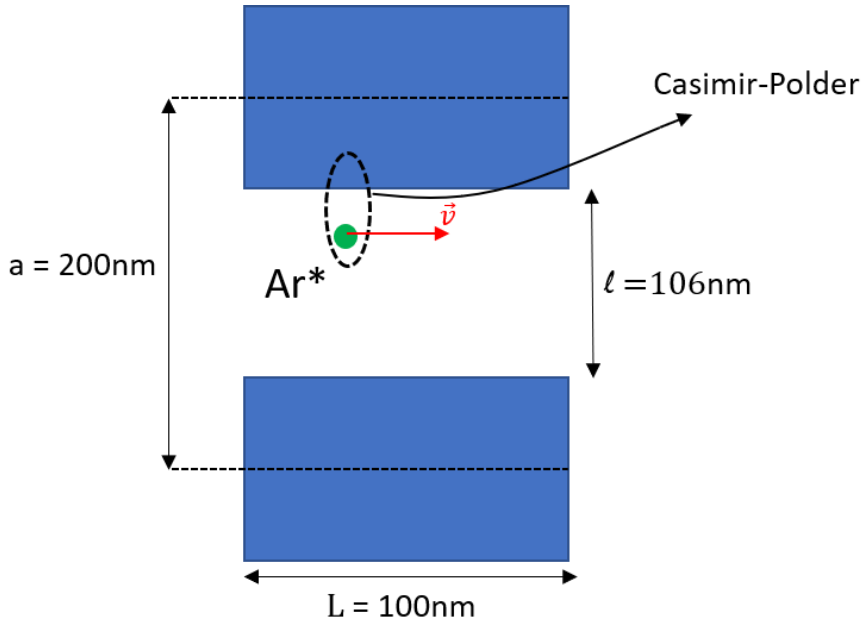
Hinds & Haroche 1992

To study the atom surface interactions, we use a nanograting. This nanograting has been manufactured by Nathalie Fabre at the IEMN (clean room in Lille, France).

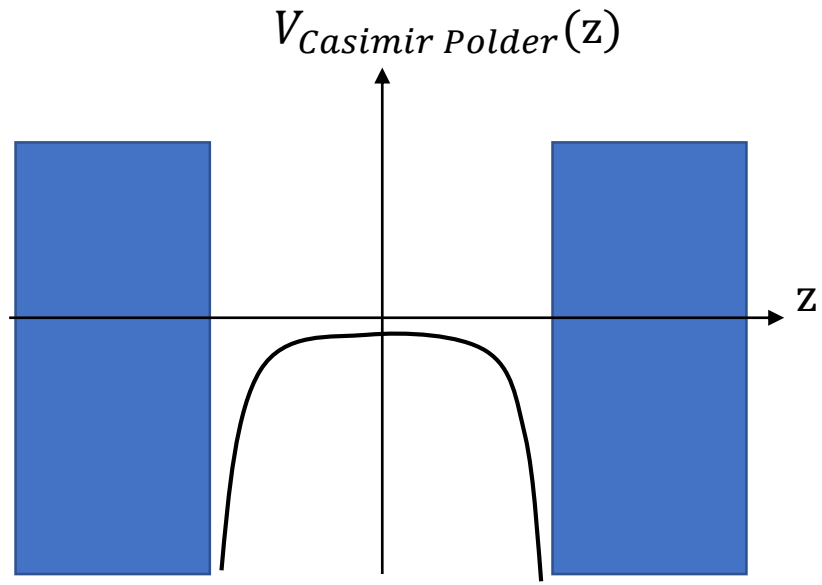
<u>Characteristics of the nanograting :</u>

- Made by electron lithography
- Period : 200nm
- Depth : 100nm
- 1x1mm²
- Well known geometry

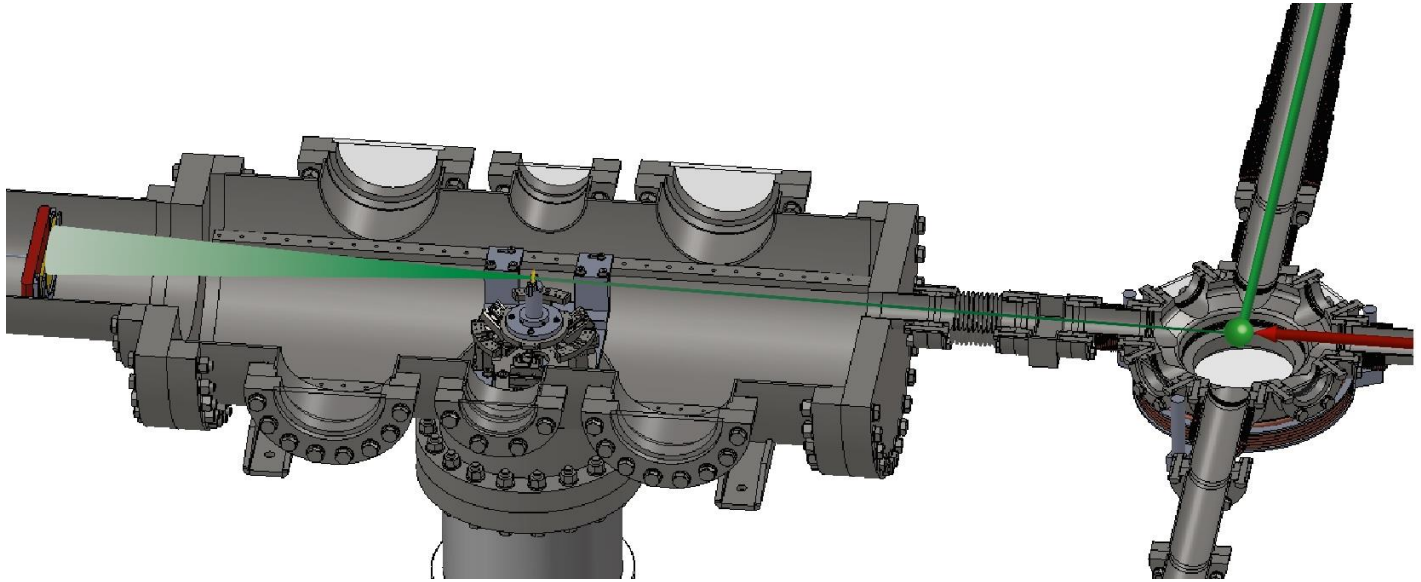




Potential shape inside a slit :



Our experimental setup is based on a slow beam of metastable argon atoms : at the begining we load a MOT, then we turn off the lasers of the trap, at the same time, we push the atom in the direction of the nanograting. The diffracted pattern is detected via a Delay Line Detector.



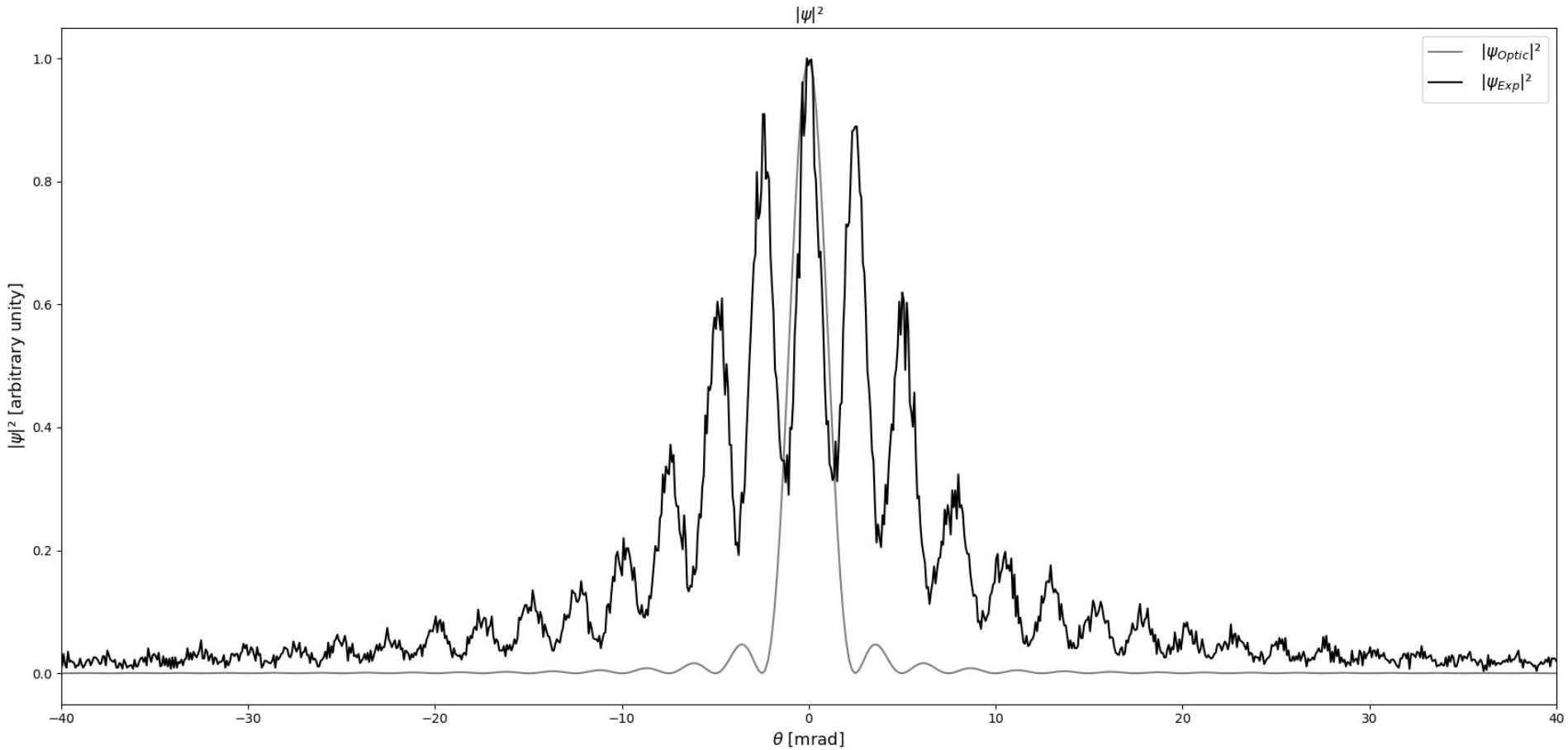
Slow beam of Ar* $^3\mathbf{P}_2$:

- Pushing laser beam
- Flux of 10^4 at/s
- Tuneable velocity between 150 and 10 m/s

T Taillandier-Loize et al 2016 J. Phys. D: Appl. Phys. 49 135503

Fraunhofer diffraction (envelope of diffraction if no atom-surface interactions) VS experimental datas

V= 20m/s



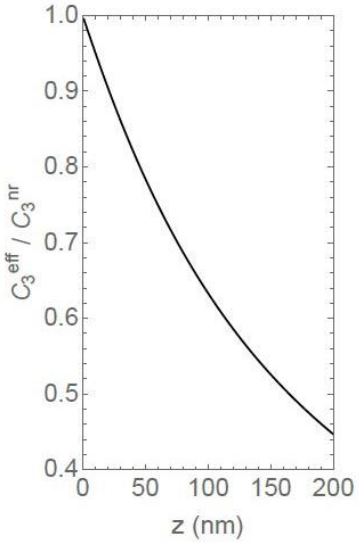
Taking into account the atom surface interactions :

Non-retarded :

$$V_{vdW} = -\frac{C_3}{z^3}$$

Retarded – Wylie and Sipe :

$$V_{WS} = -\frac{C_3(z)}{z^3}$$



V= 20m/s