TEST OF THE T - INVARIANCE WITH POLARIZATION - ASYMMETRY THEOREM IN MIRROR REFLECTION OF THE SLOW NEUTRONS

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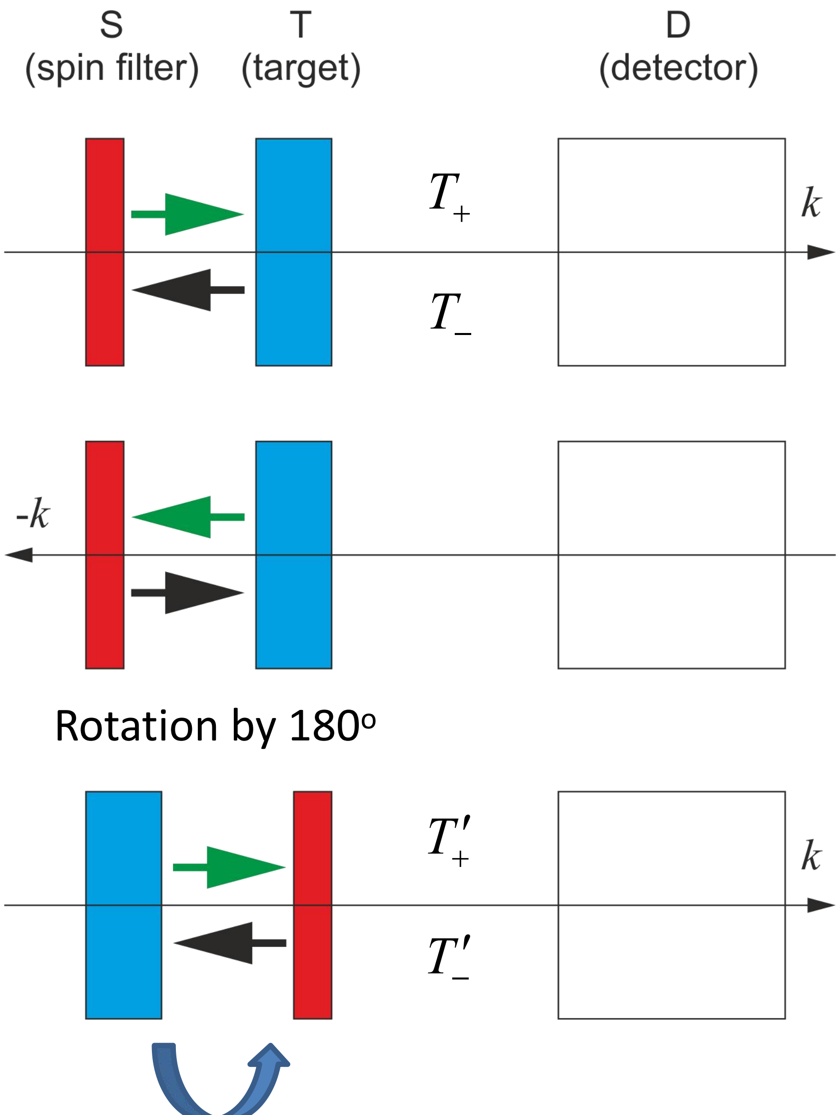
POLARIZATION – ASYMMETRY (P-A) THEOREM

If T – invariance holds, then **polarization** of the initially unpolarized particles with spin ½ after their propagation thru a target is **equal to asymmetry** of scattering of the same polarized particles.

R. H. Dalitz (1952)

Test of T-invariance in neutron transmission thru a unpolarized target with P-A theorem



Transmission asymmetry

$$A = \frac{T_+ - T_-}{T_+ + T_-}$$

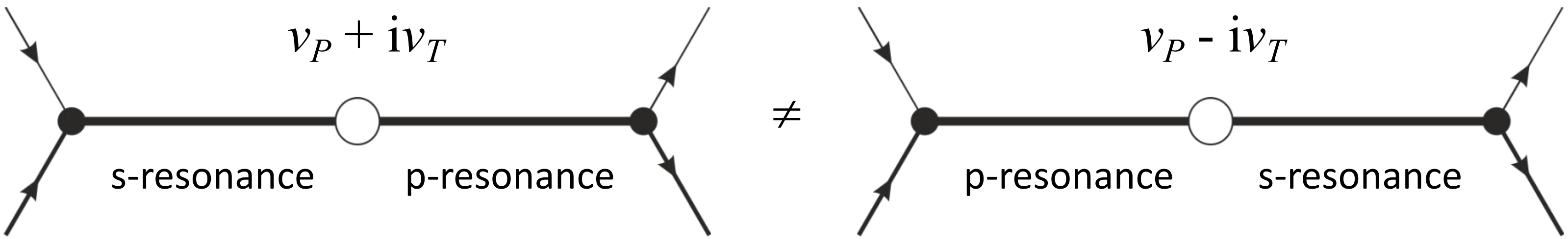
Time reversal

Polarization, arising in a beam

$$P = \frac{T'_+ - T'_-}{T'_+ + T'_-}$$

If T – invariance breaks, then $A \neq P$

Two-levels model of the simultaneous space parity and T – invariance violations in a resonance compound nucleolus interaction



$$A = \tanh\left[(\sigma_P + \sigma_T)pn_t d\right]$$

$$P = \tanh\left[(\sigma_P - \sigma_T)pn_t d\right]$$

$$A - T \approx 2\sigma_T pn_t d$$

$$A - P \approx \frac{ƛ^2 g_J \sqrt{\Gamma_{ns}\Gamma_{n1/2}}}{E_p - E_s} \cdot \frac{v_T}{E_p - E_s} \cdot \frac{E_p - E_s}{\Gamma}$$

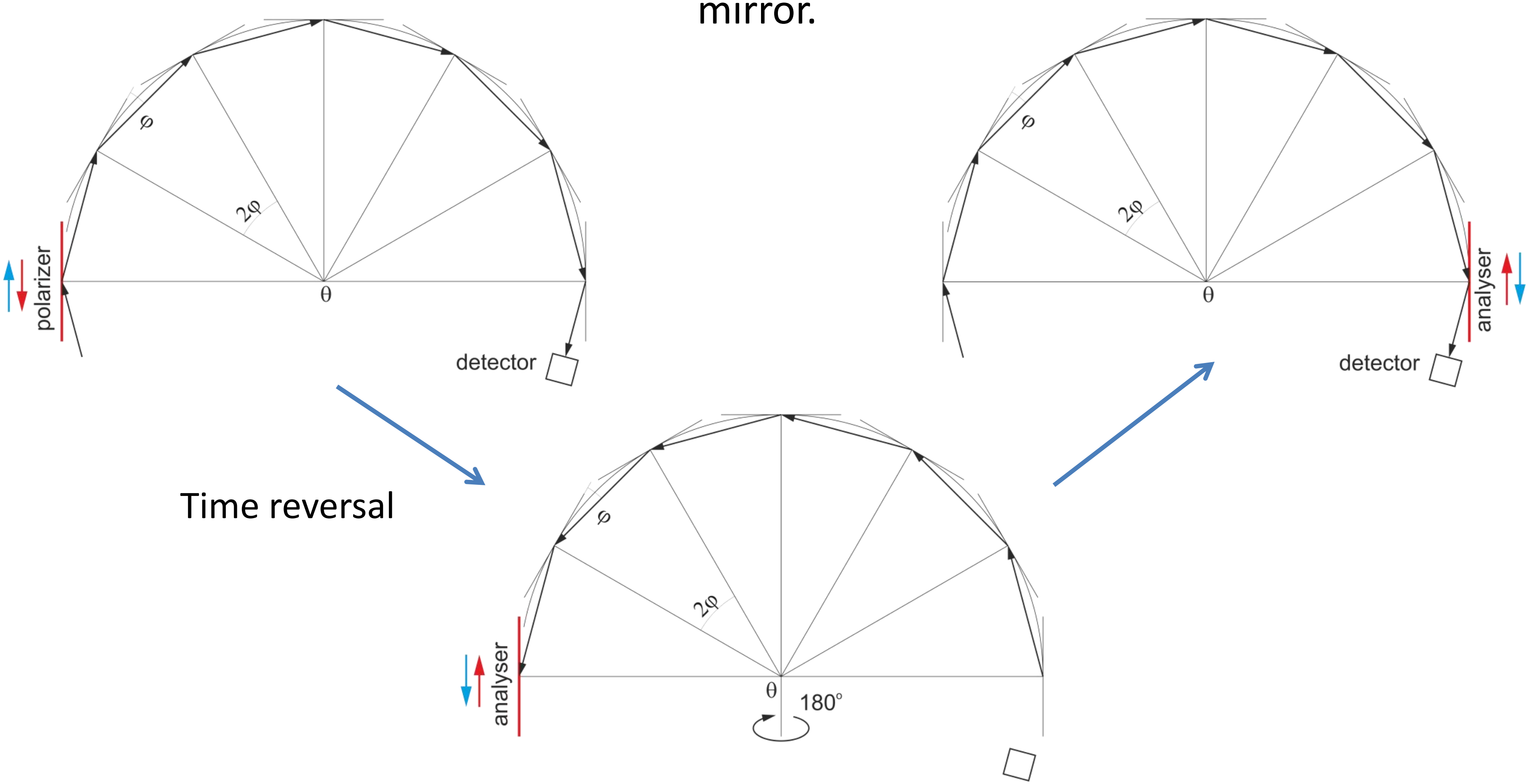
dynamical

resonance

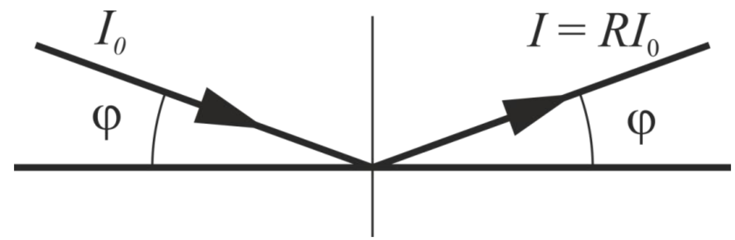
Whispering gallery

Propagation of the acoustic waves along the walls in a round structures due to the total multiple reflection and a formation of the standing wave.

The same effect takes place for the cold neutron wave λ when it reflects along a round mirror.



Coefficient of a mirror reflection *R*



$$R = \left(\frac{1 - \sqrt{1 - \varphi_c^2 / \varphi^2}}{1 + \sqrt{1 - \varphi_c^2 / \varphi^2}} \right)^2$$

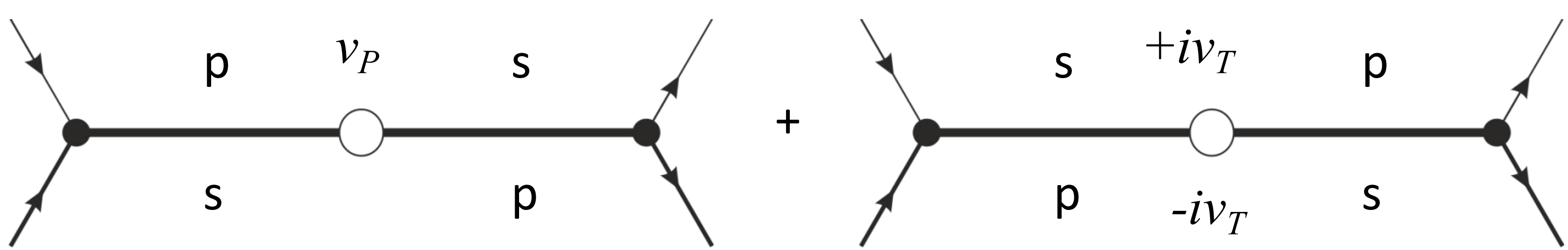
Critical angle:

$$\varphi_c = \lambda \sqrt{b n_t / \pi}$$

b is an amplitude of a coherent scattering, which defines a neutron transmission as well.

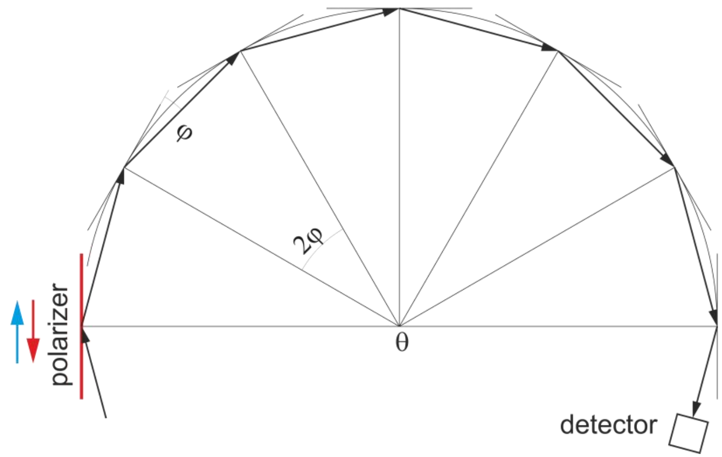
$$b = b_0 \pm p_n \left(b_P \pm i b_T \right)$$

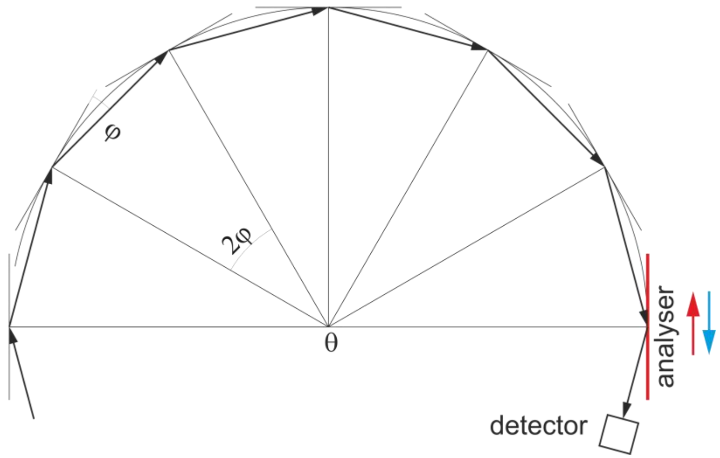
b_P ib_T



In a case of multiple N reflections of a neutron from a mirror :

$$N = \theta / 2\varphi_c$$





$$P = 2N\sqrt{(b_P + ib_T)/b}$$

$$A = 2N\sqrt{(b_P - ib_T)/b}$$

According to P-A theorem:

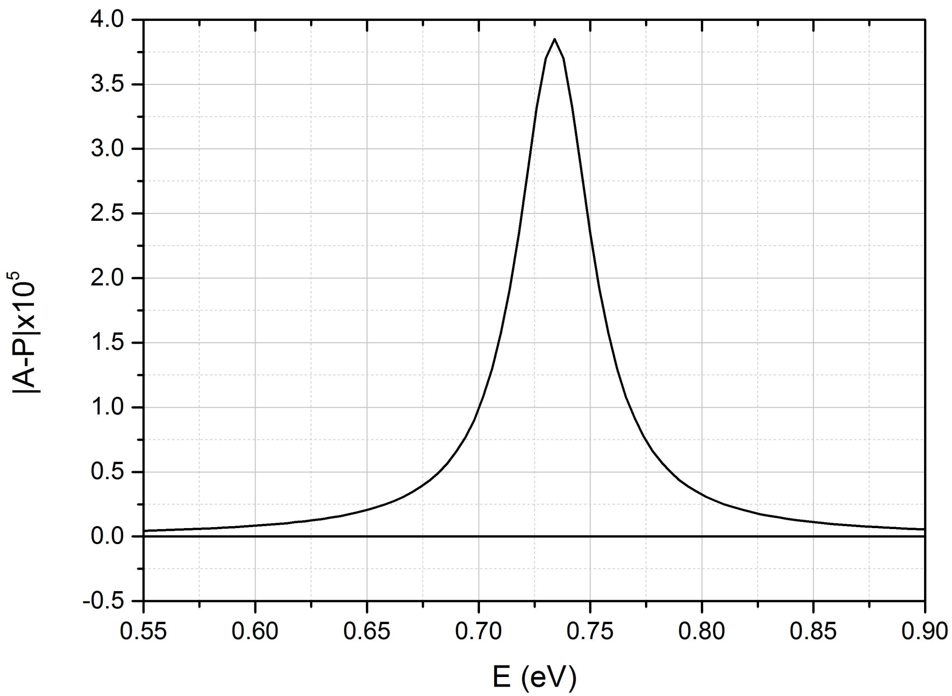
$$|A - P| \approx 2N\frac{b_T}{b_P} \neq 0$$

Si Mirror (ILL),
R = 2.5 cm

Tested for λ = 3.9 A
(5.4×10^{-3} eV)

Example for ^{139}La (E_p = 0.734 eV, v_P = 4.2×10^{-3} eV,) and $\theta = \pi/2$

E (eV)	φ_c (rad)	N	A - P
10^{-4}	0.0040	197	2.5×10^{-5}
10^{-3}	0.0013	623	1.4×10^{-4}
10^{-2}	0.0004	1970	7.9×10^{-4}



For p-wave resonance
$A - P = 3.7\times10^{-5}$

Conclusions

1. A big number of reflection may gain an effect jf T – violation even more than in resonance.

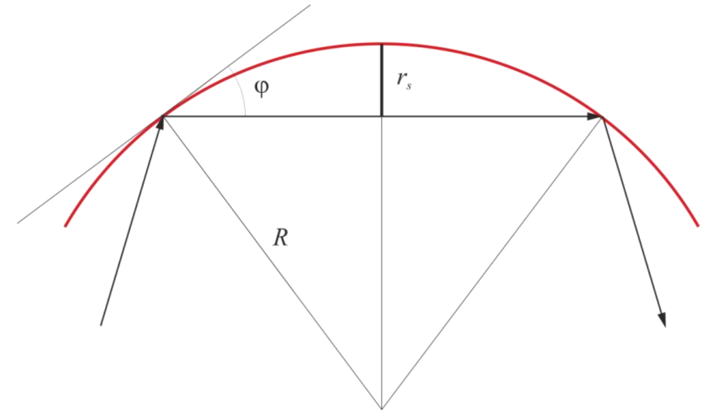
2. Test of P-A theorem with whispering gallery is more complicate than that in transmission, since a high quality mirror with special coating ($LaAlO_3$) required.

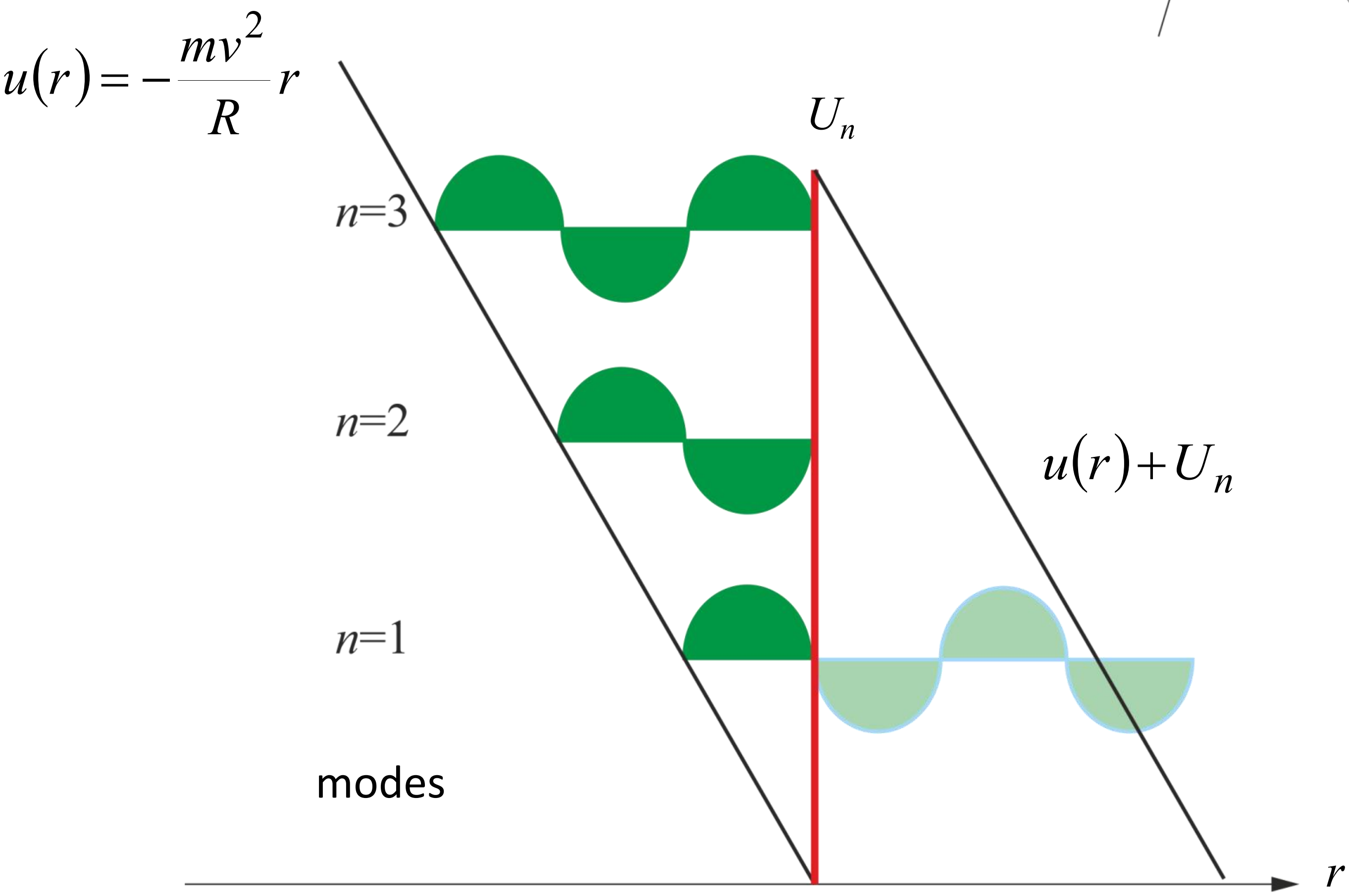
3. Gravitation does not affects on neutron reflections and do not provides the false effects.

Thank You!

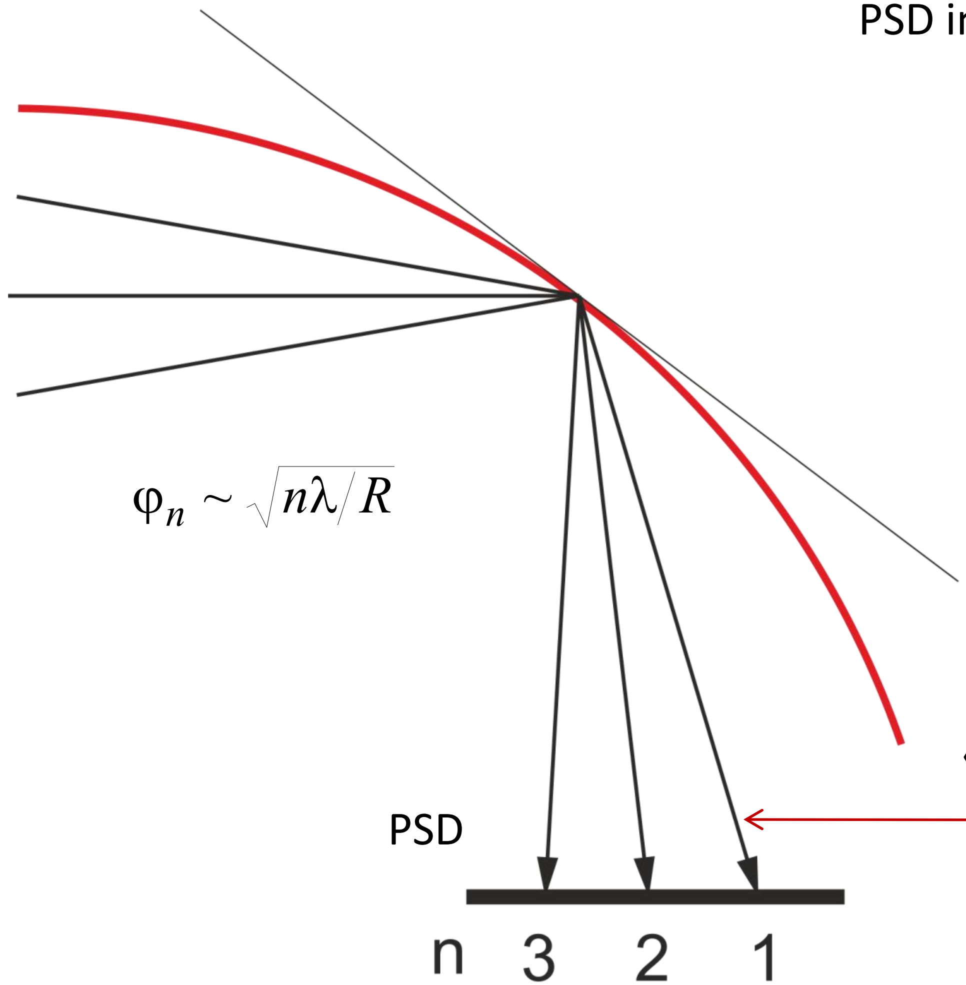
Backup slides

Centrifugal waveguide





Dispersion of the sliding angles for the different modes in centrifugal waveguide



«zero-effect» due to low sensitivity to U_n

PSD image