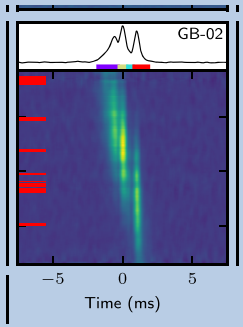
Drifts, periodicity quenching, polarization from reflections

Jim Cordes, Cornell University

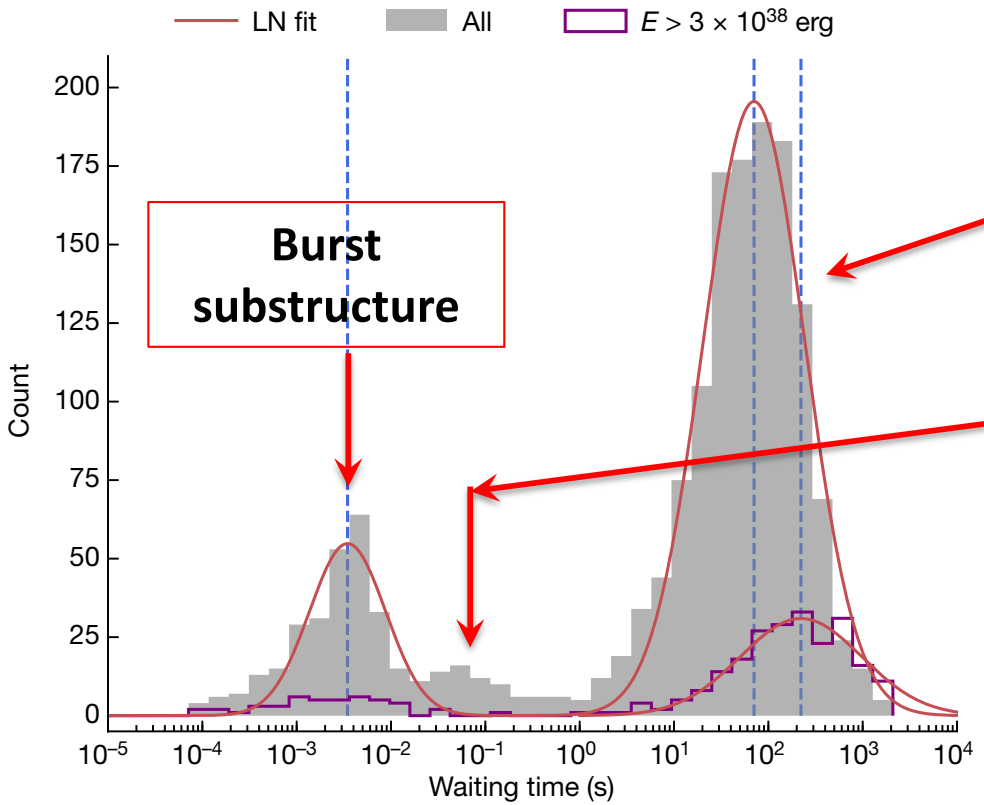
Features perhaps related to FRB environments

1. **No high-Q fast periodicities** $Q = \frac{f}{\Delta f} = \frac{P}{\Delta P}$
   - Cases of transient low-Q sub-sec periods
   - Two cases of slow periodicities (windows of opportunity) (16d and 160d) *suggestive* of spin precession. Where is the spin?
2. **Time frequency drifts** $d\nu/dt < 0$ $-\langle d\nu/dt\rangle \propto \nu^x, \quad x \sim 1$
   - Repeaters only (?)
   - Variable numbers of spectral islands and drift rates



3. **Flat polarization angles** across (some) bursts

Li et al. 2021 FRB121102 w/ FAST



Burst substructure

Typical separations of bursts above threshold

Low-Q periodicity?

Fig. 3 | Waiting time distribution of the bursts. The grey bar and solid red curve show the distribution of waiting time and its log-normal (LN) fit. The high-energy component ($E > 3 \times 10^{38}$ erg) is shown by a solid purple line. The three fitted peak waiting times (blue dashed vertical lines) from left to right are 3.4 ± 1.0 ms, 70 ± 12 s, and 220 ± 100 s. The peaks around 70 s and 220 s in the waiting time distribution are close to the average values for the respective samples (full and high energy). This is consistent with a stochastic process (see the main text and Methods for further discussion).

Nature | Vol 598 | 14 October 2021 | **269**

Individual time series show tendency for bursts with separations of 50 to 200 ms

Why not periodic?

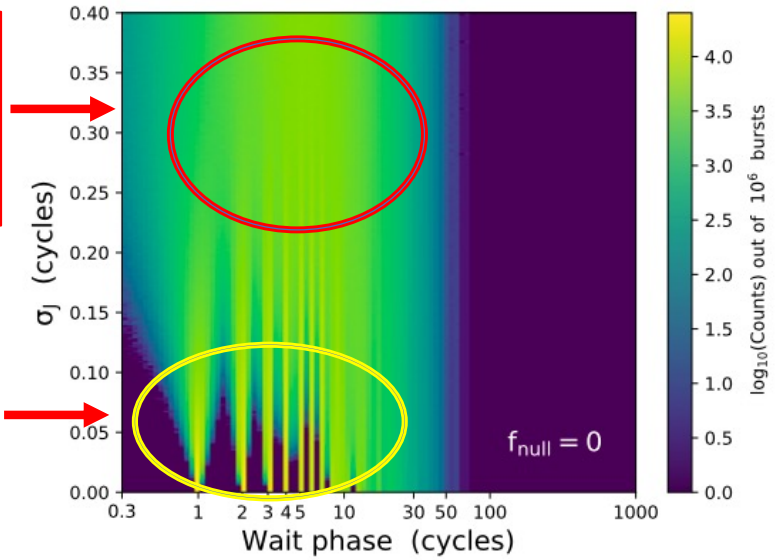
Masking of periodicities by phase jitter + nulls

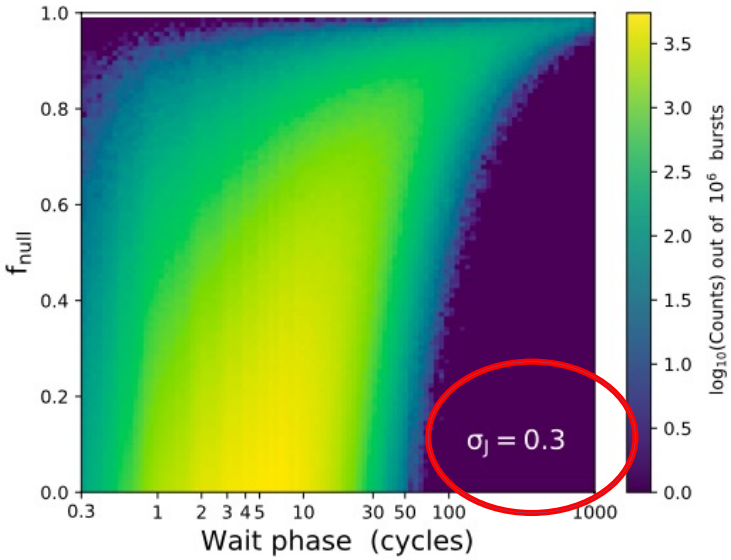
lighthouse with a very wobbly intermittent light beam

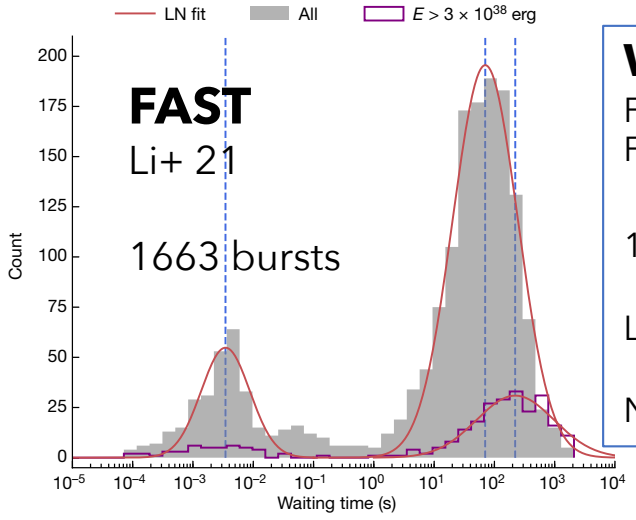
JMC, Wasserman et al.

Phase jitter > 0.3 cy to account for wait-time

Peaks at multiples of spin period if phase coherent







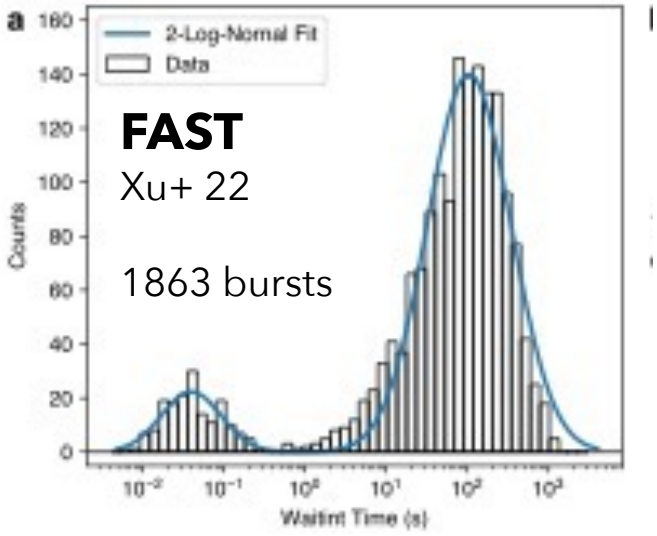
Wait-time distributions

FRB 20121102A (left)
FRB 20201124A (right)

1st peak = burst substructure

Large peak at ~100 s

No evidence for fast periodicity

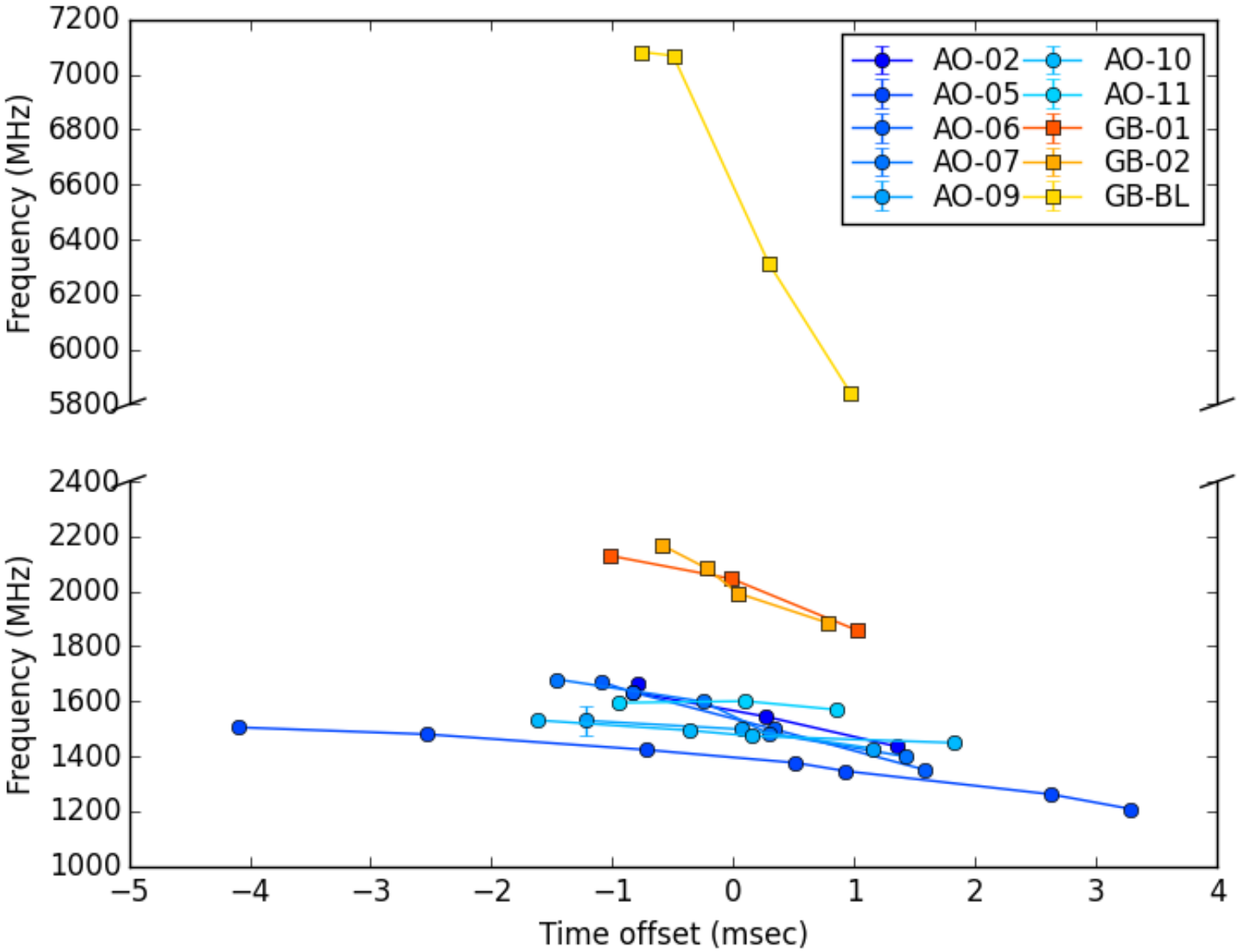


Periodicity quenching possibilities

- May signify emission well outside magnetosphere
  - Shock models etc. … decoupling from spin
- Pulsar-like rotation/beaming with large altitude variability inside the magnetosphere
- Any post emission process that induces delays > 1/3 P

Drift rates for FRB 121102

[Hessels et al. 2019]



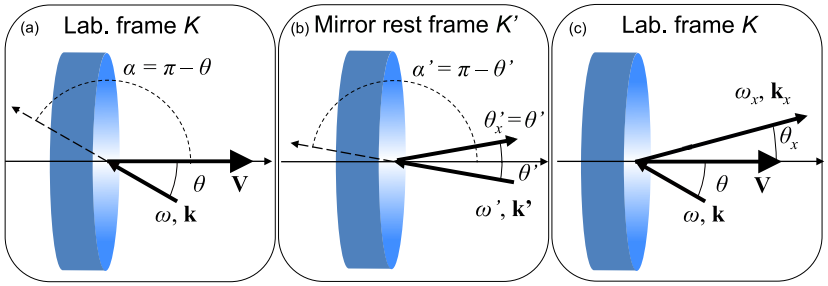
quantum beam science

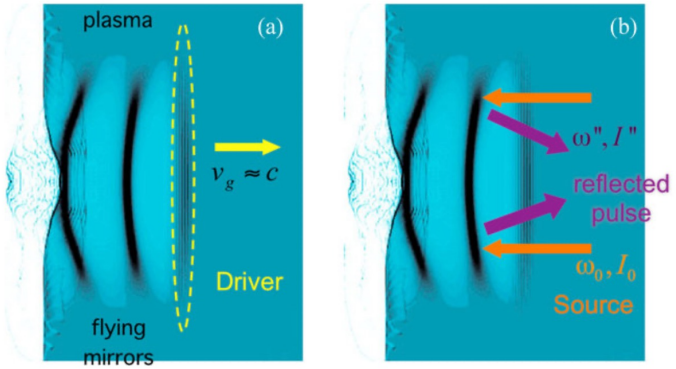
MDPI

Review

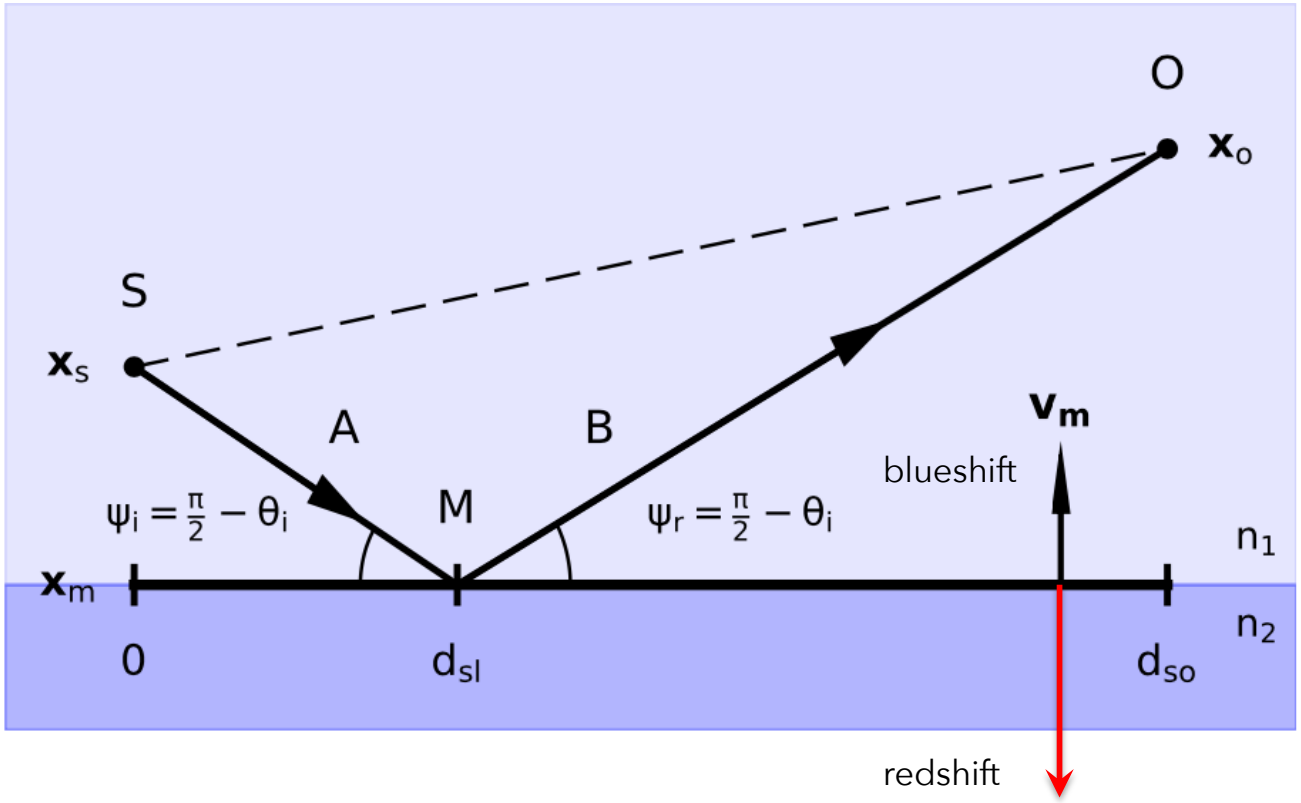
Coherent, Short-Pulse X-ray Generation via Relativistic Flying Mirrors

Masaki Kando [1,*,†], Timur Zh. Esirkepov [1,†], James K. Koga [1,†], Alexander S. Pirozhkov [1,†], and Sergei V. Bulanov [1,2,†]





Moving mirrors



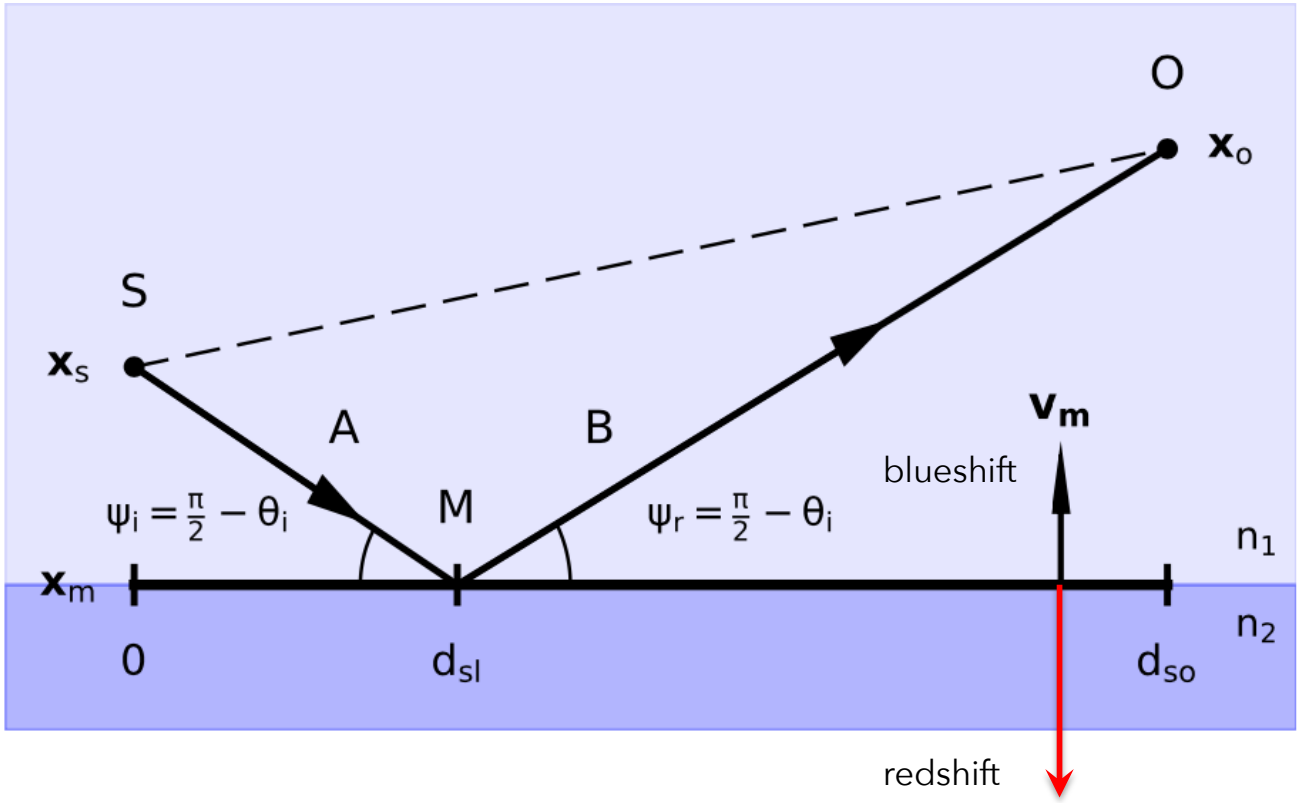
Angle of reflection
≠
angle of incidence

Reflected ray is blue shifted or redshifted

Reflected ray is delayed

Reflections can be polarization selective

Moving mirrors

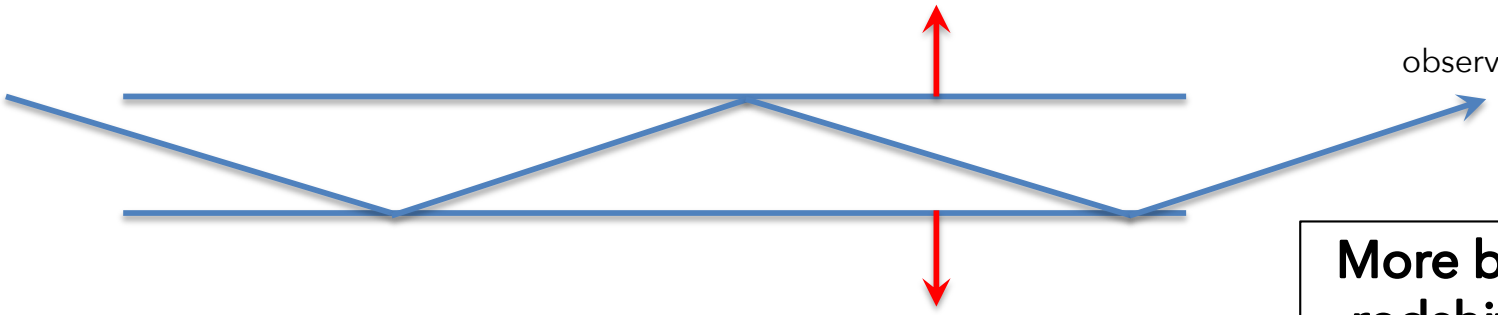


Angle of reflection
≠
angle of incidence

Reflected ray is blue shifted or redshifted

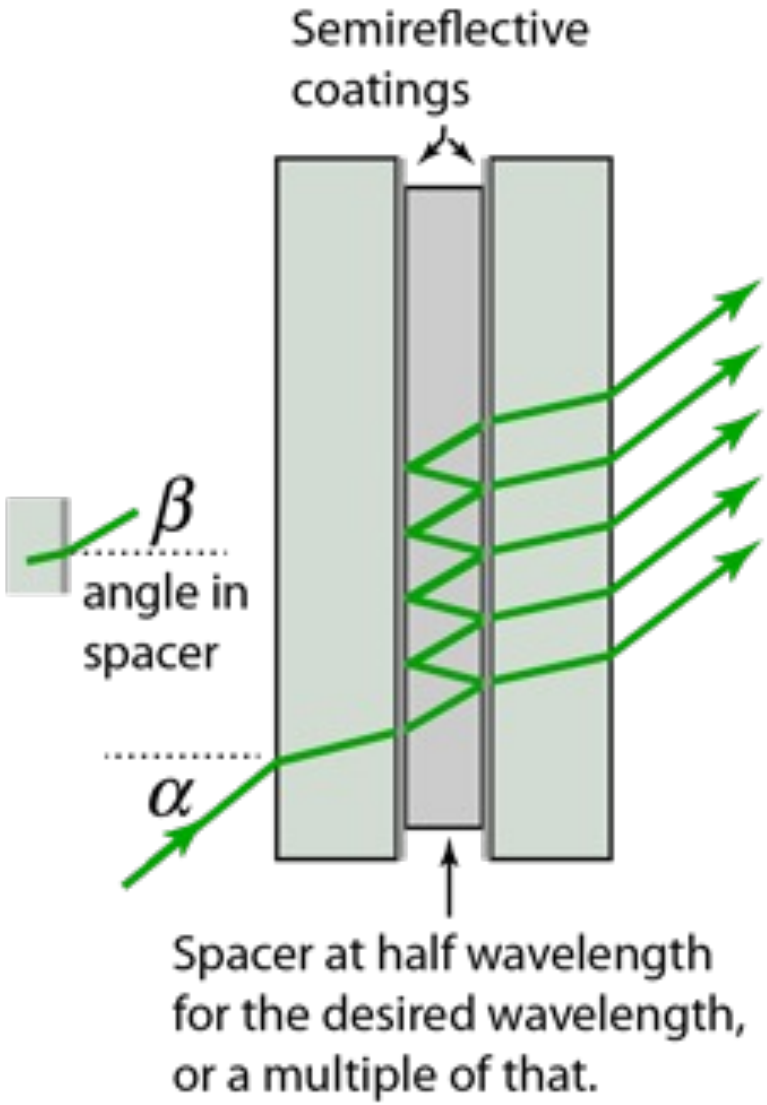
Reflected ray is delayed

Reflections can be polarization selective



More bounces → larger redshifts, larger delays

Interference filters, dichroics



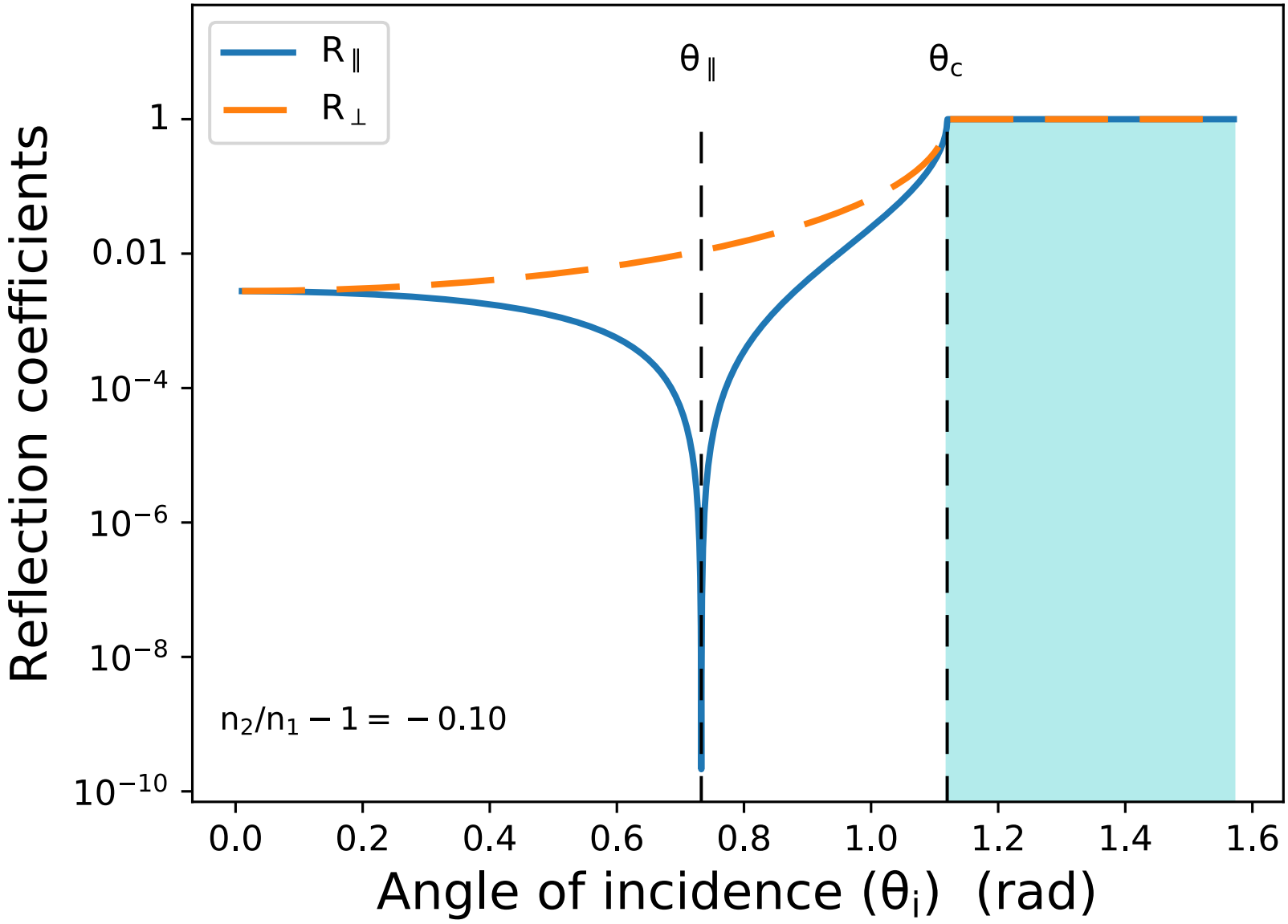
Transmission effects

Is radiation narrowband before reflecting?

Or induced?

Moving boundaries ⇒ detuning (sloppy filter)

More reflections ⇒ larger delays and frequency shifts


R∥
R⊥
θ∥
θc
1
0.01
10−4
10−6
10−8
10−10
n2/n1 − 1 = −0.10
Reflection coefficients
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
Angle of incidence (θi) (rad)