

Generation and Control of Squeezed Light Fields

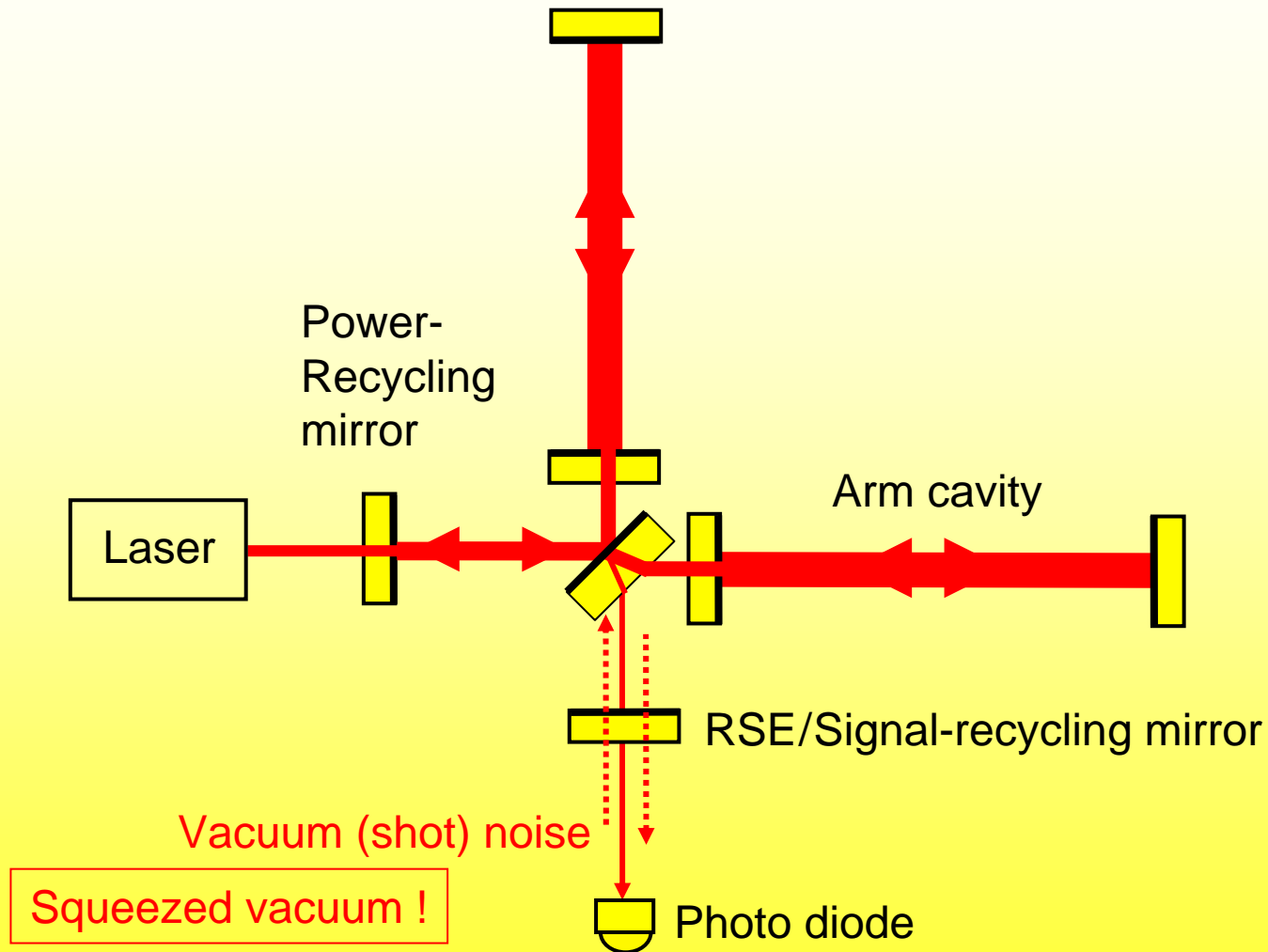
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N. Lastzka, M. Mehmet, J. DiGuglielmo und K. Danzmann



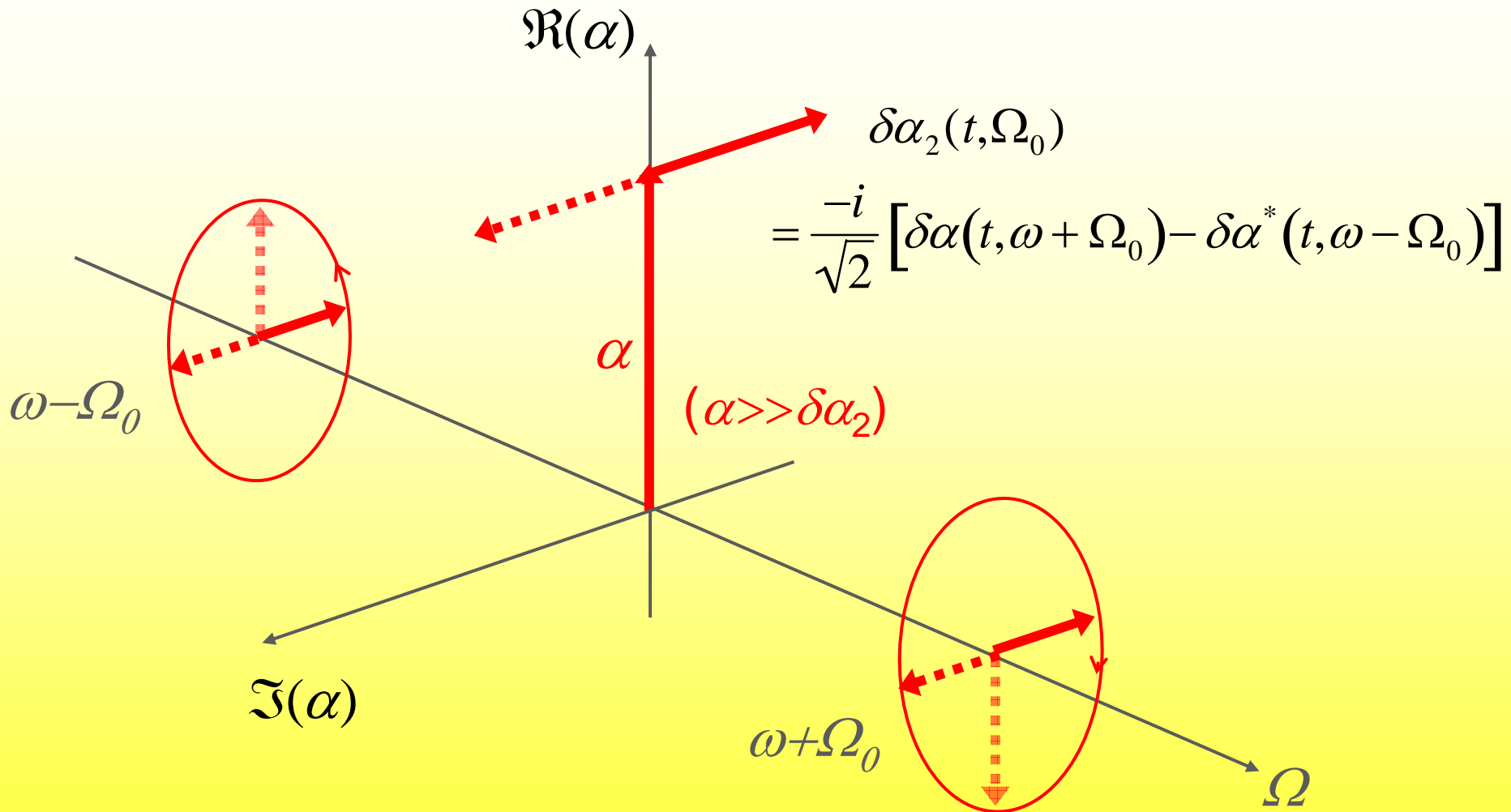
Albert-Einstein-Institut Hannover,
Max-Planck-Institut für Gravitationsphysik und
Institut für Gravitationsphysik, Universität Hannover



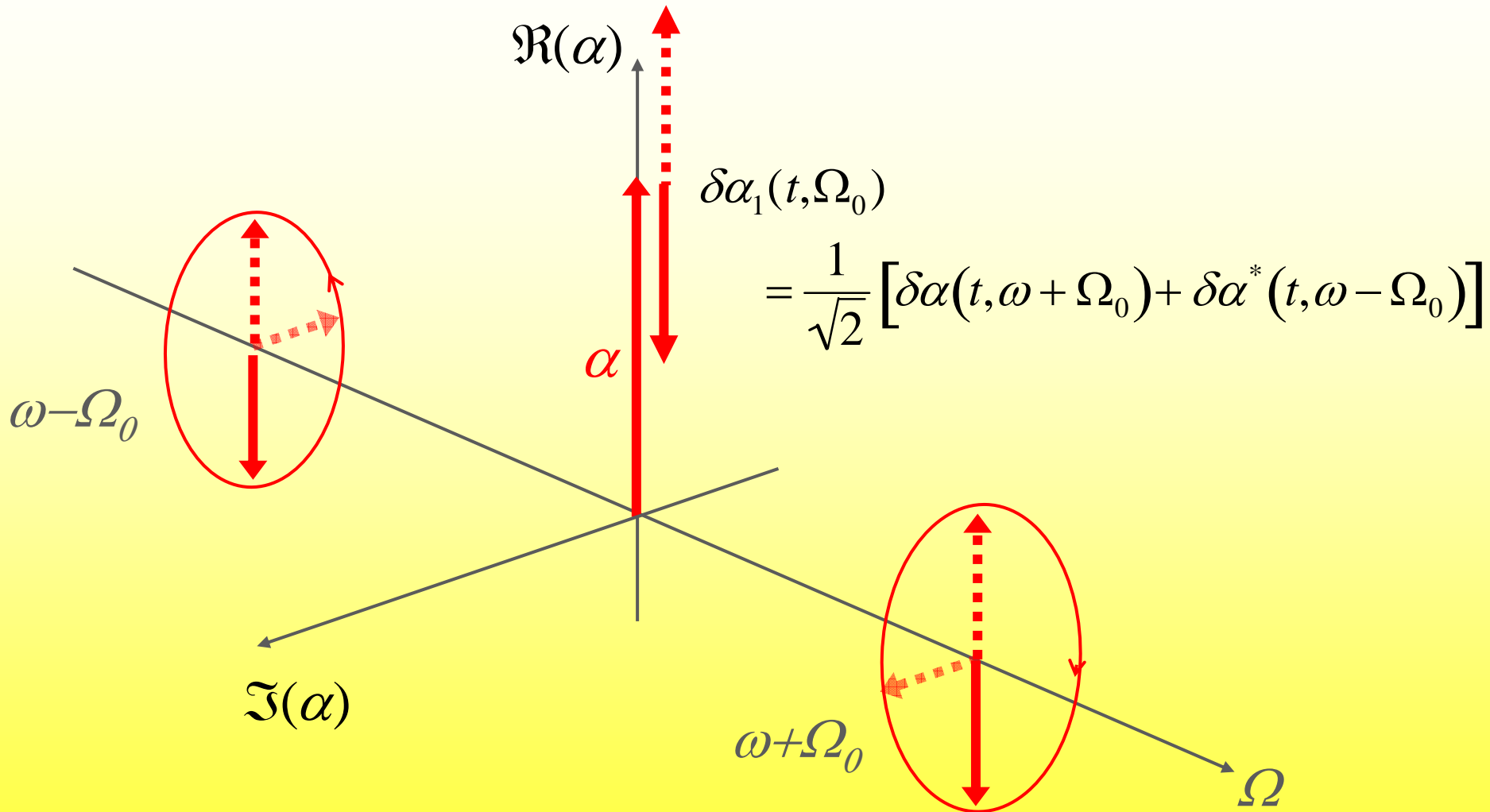
Techniques against Shot Noise



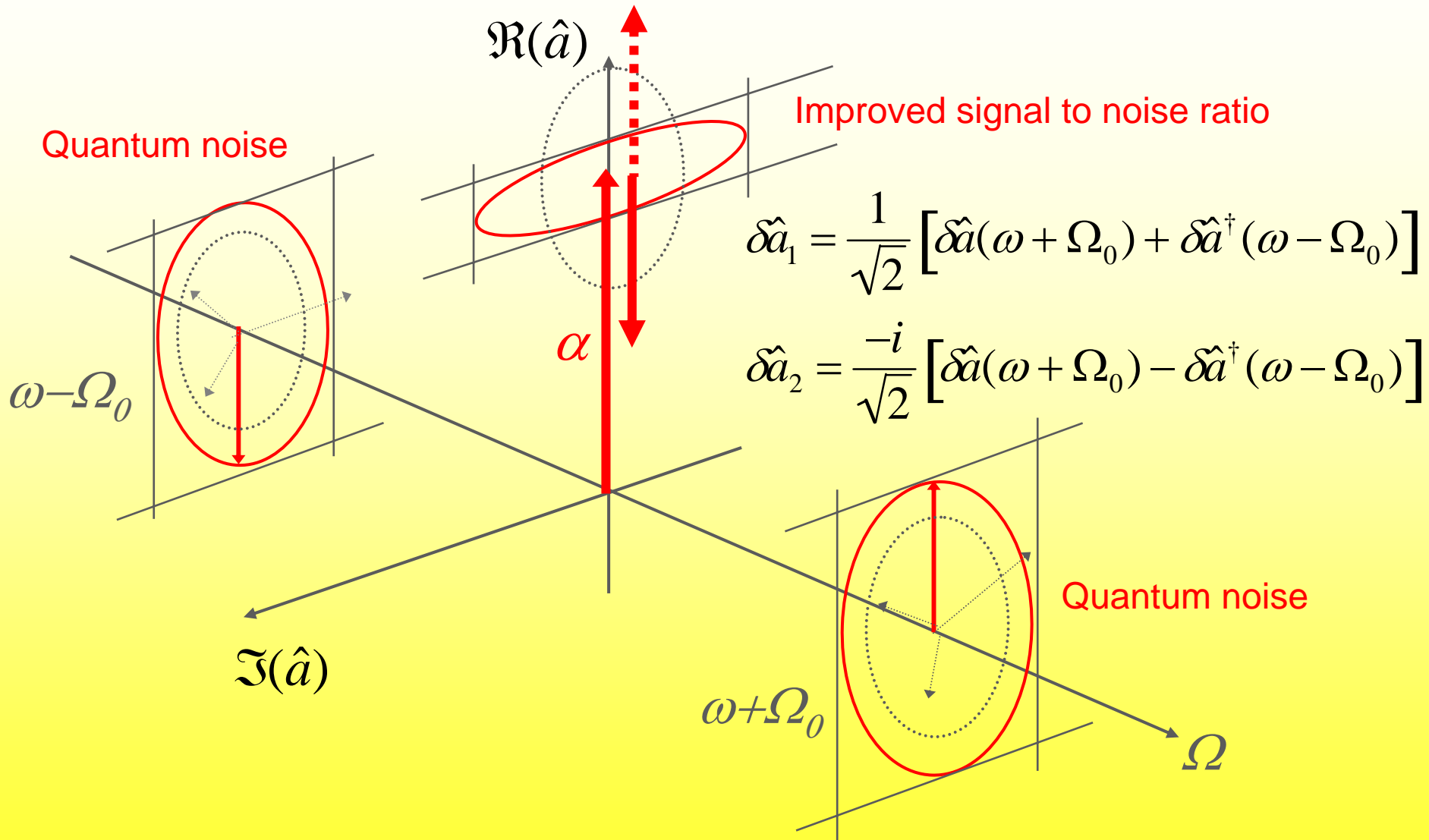
Phase Modulation at Ω_0



Amplitude Modulation at Ω_0

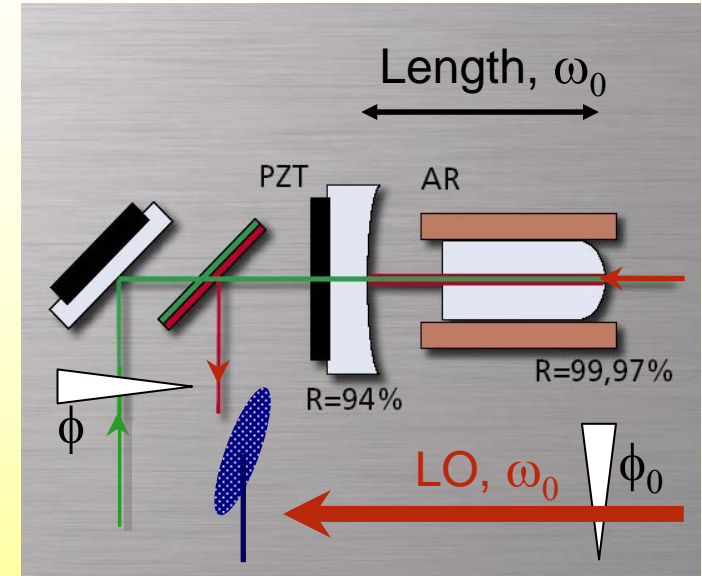
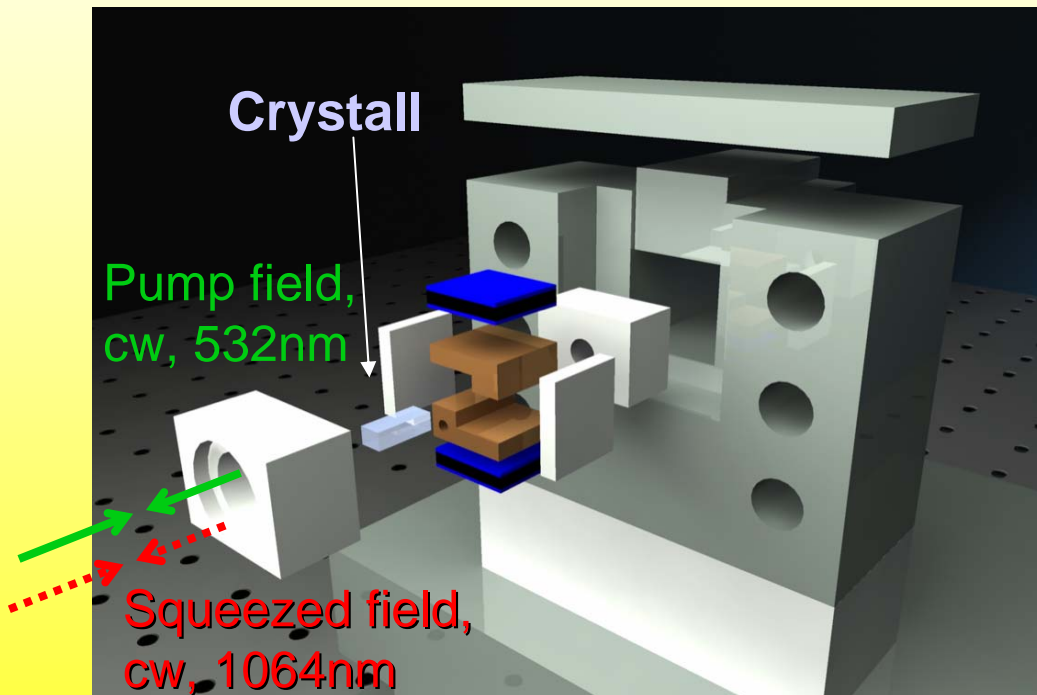


Amplitude Squeezing at Ω_0

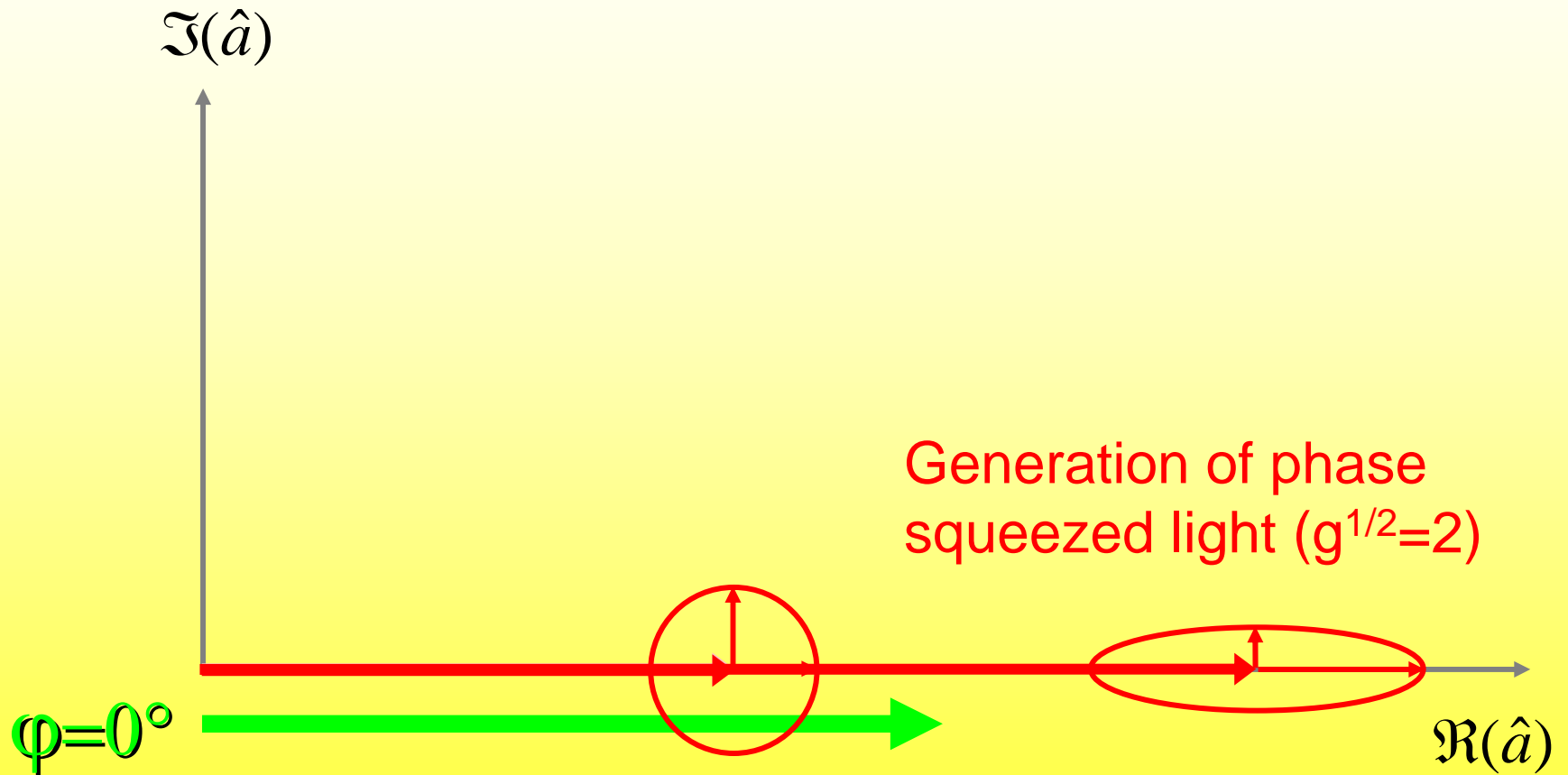


Generation of Squeezed Fields

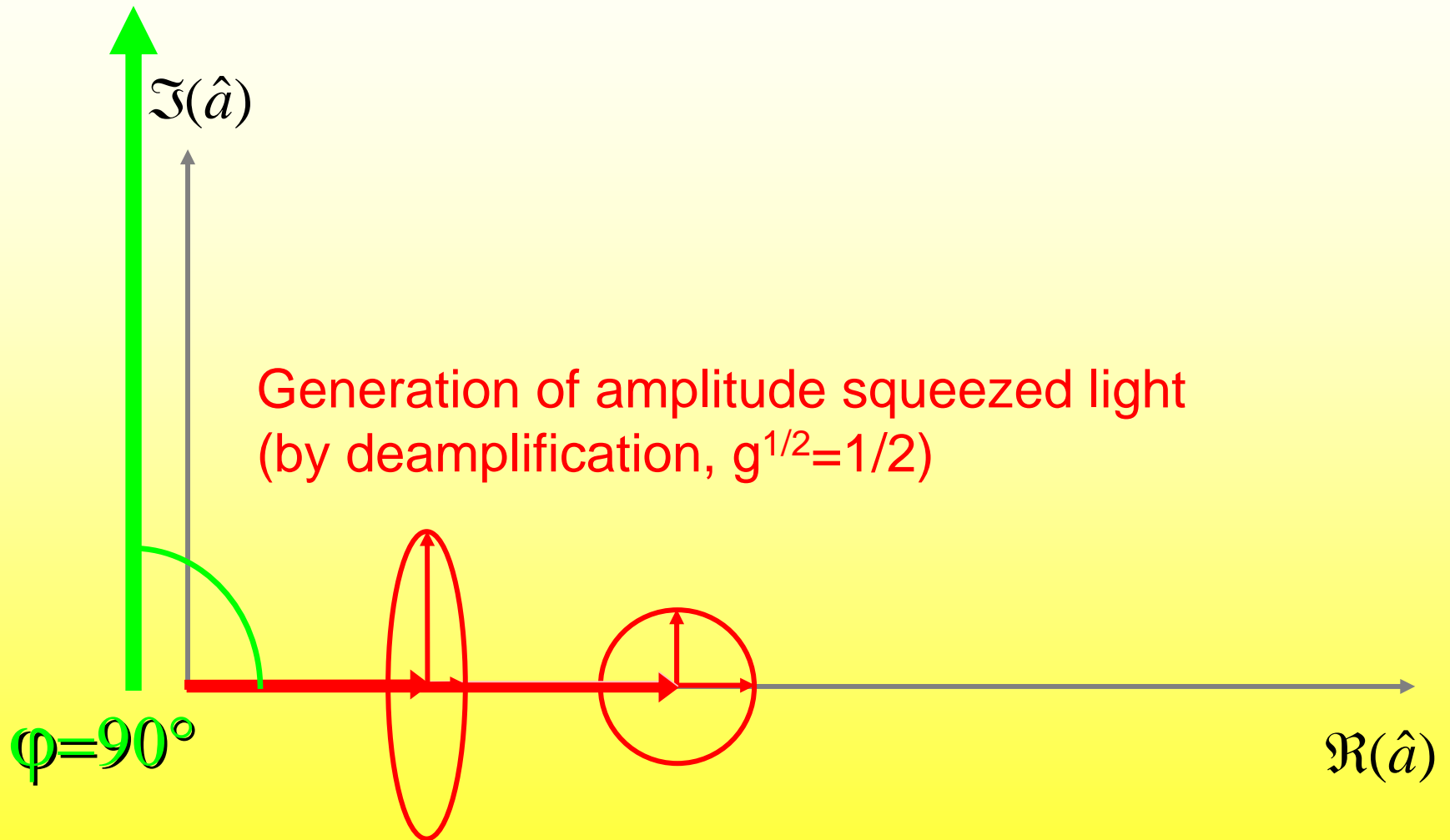
Standard design of a squeezed field source,
(Optical parametric amplifier,
resonator with MgO:LiNbO₃-medium)



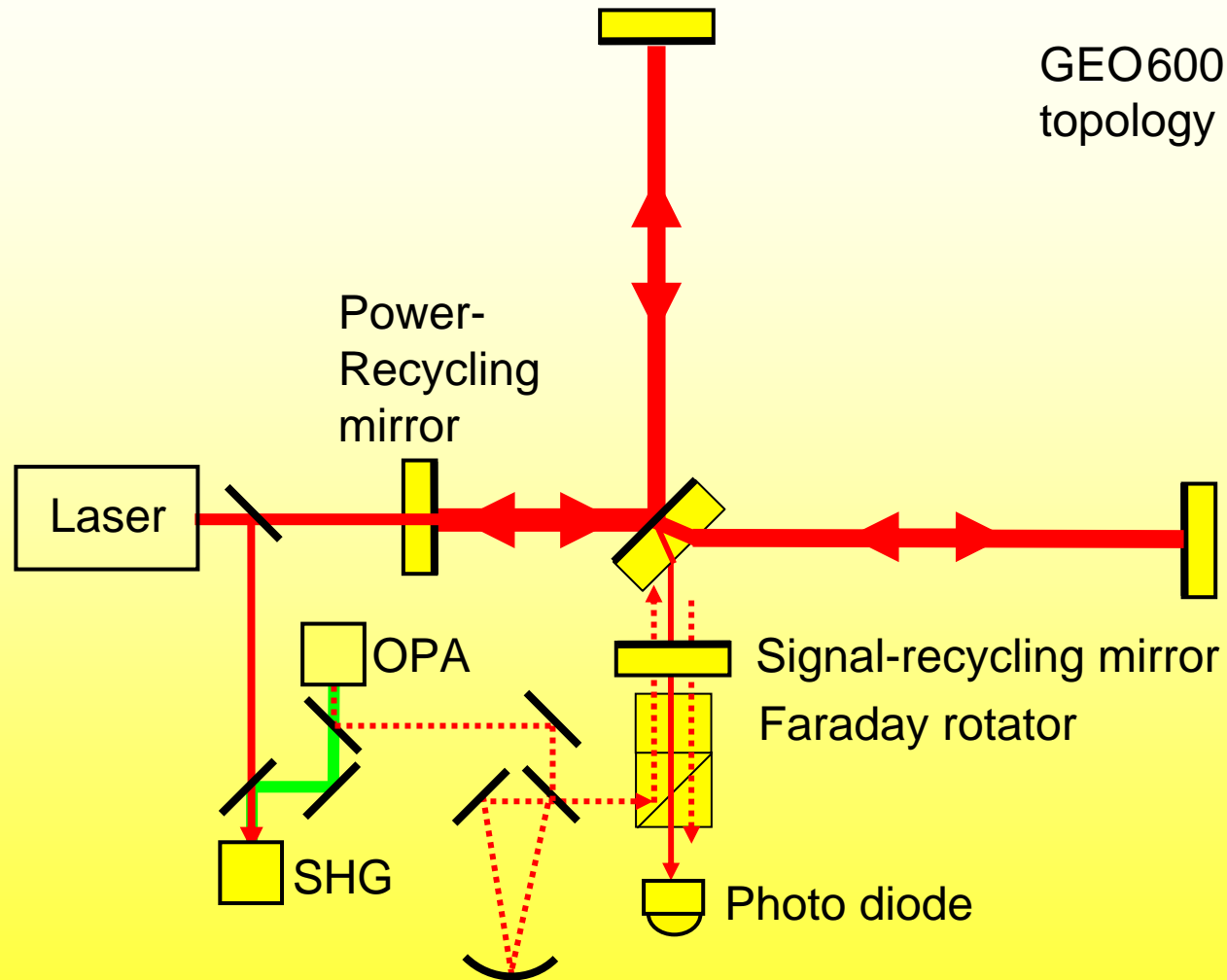
Optical Parametric Amplification



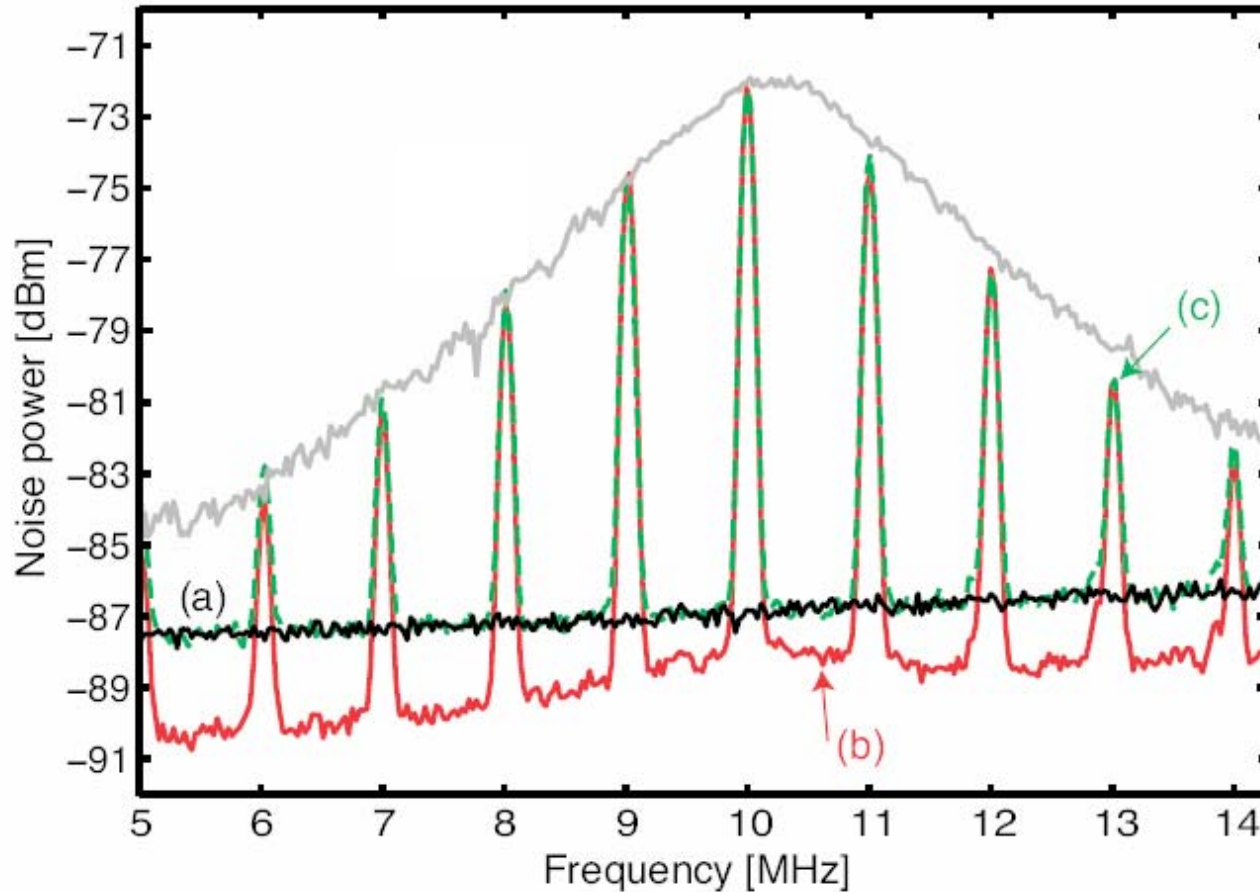
Optical Parametric Amplification



“Squeezing” and Signal-Recycling



“Squeezing” and Signal-Recycling

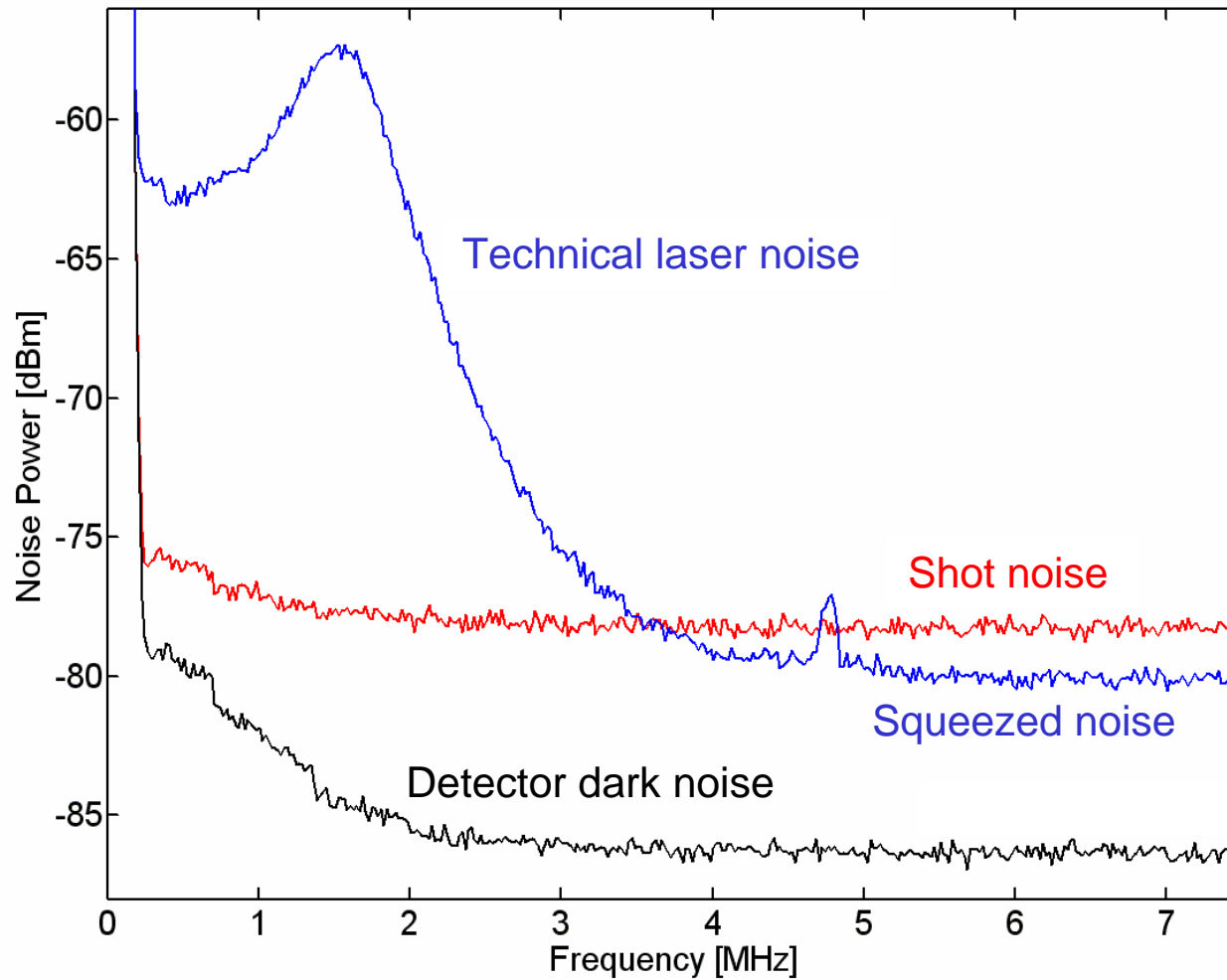


Signals (c)

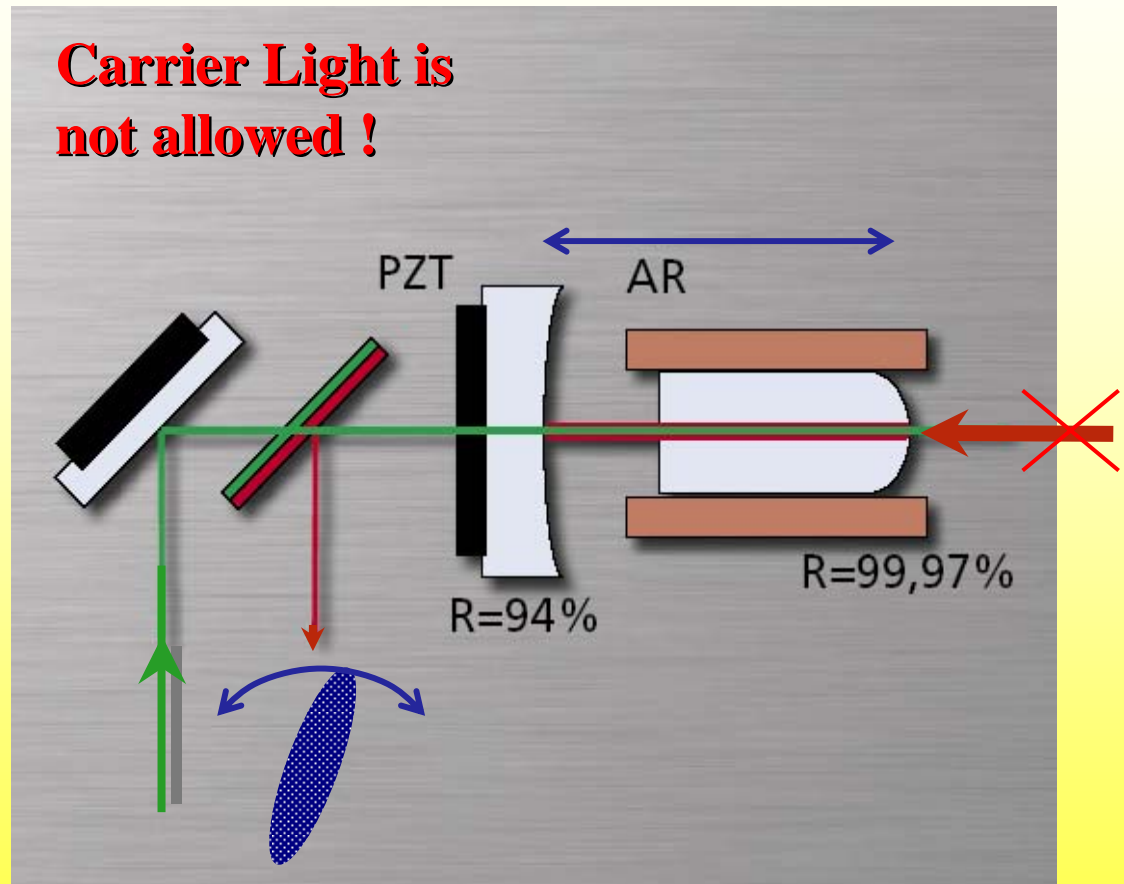
Vacuum (a)

Squeezed vacuum + signal (b)

Generation of Squeezed Fields



Control of Squeezed Vacuum Fields



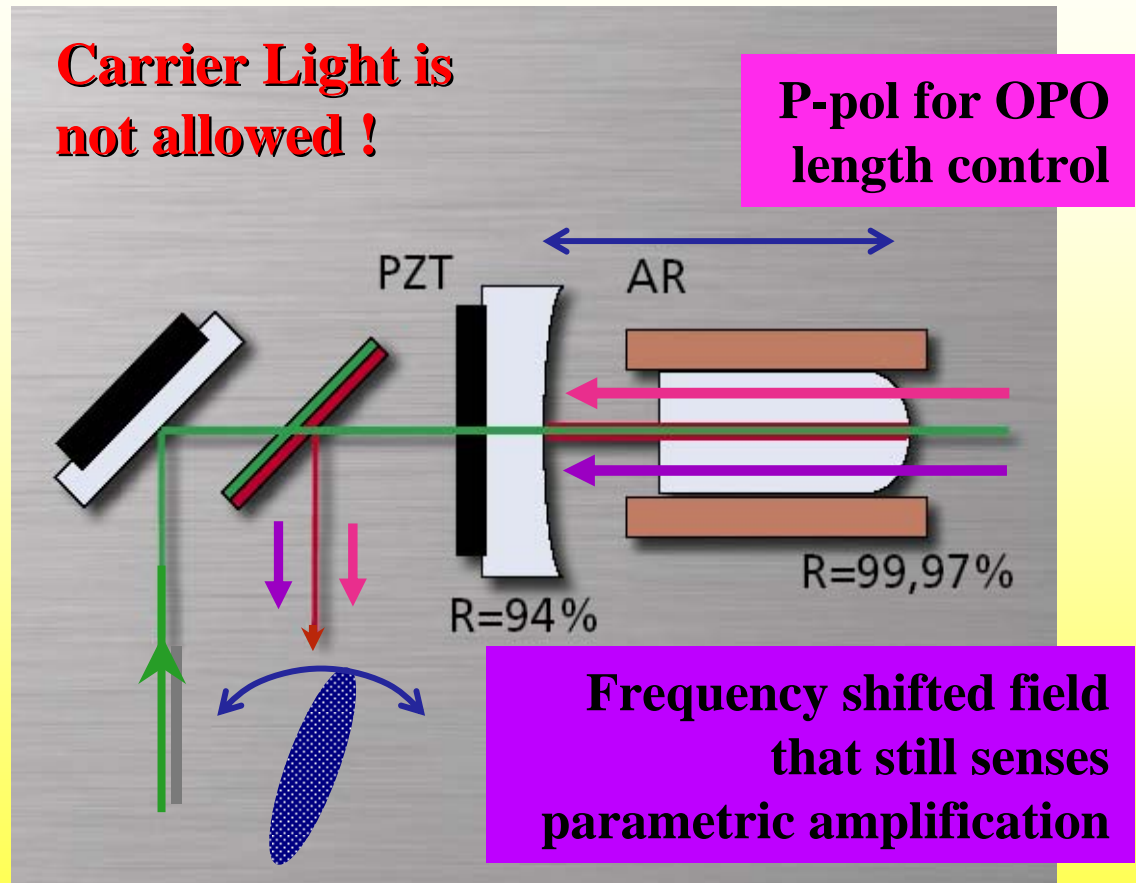
Control of Squeezed Vacuum Fields

General concept:

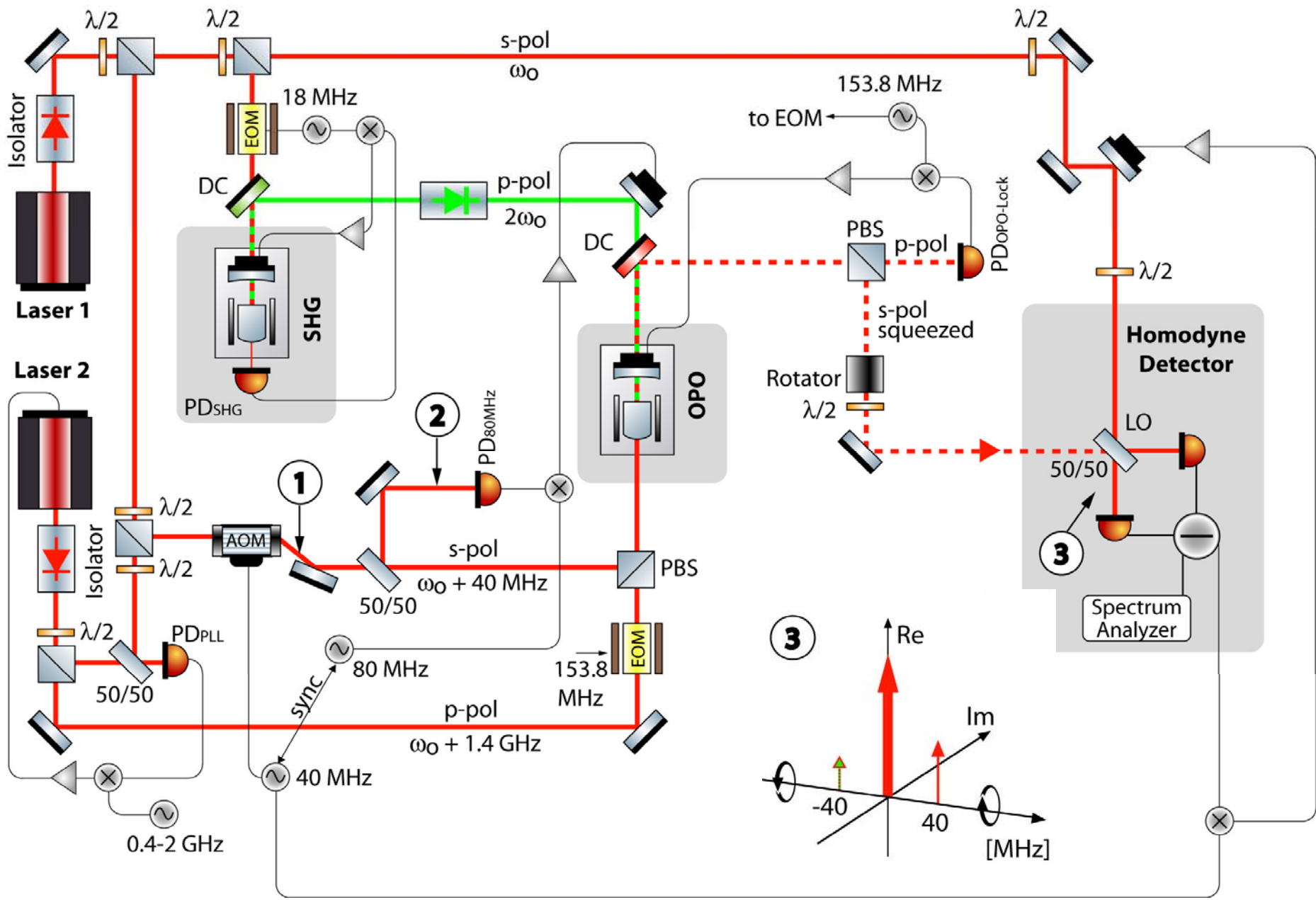
Use coherent but not interfering control fields:

Frequency shifted fields

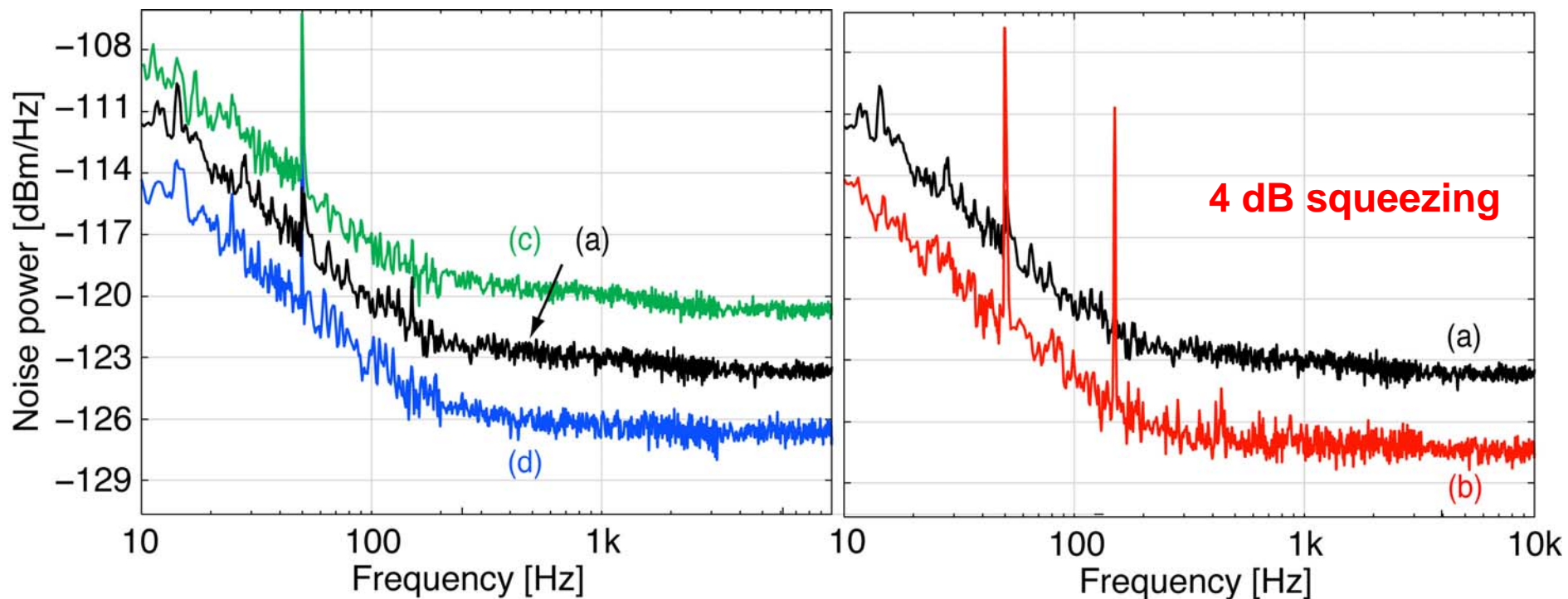
First audio-band squeezing:
[McKenzie et al., PRL **93**, 161105 (2004)]



New experiment !



Squeezing in the GW Detection Band



(a) Shot noise, $88 \mu\text{W}$

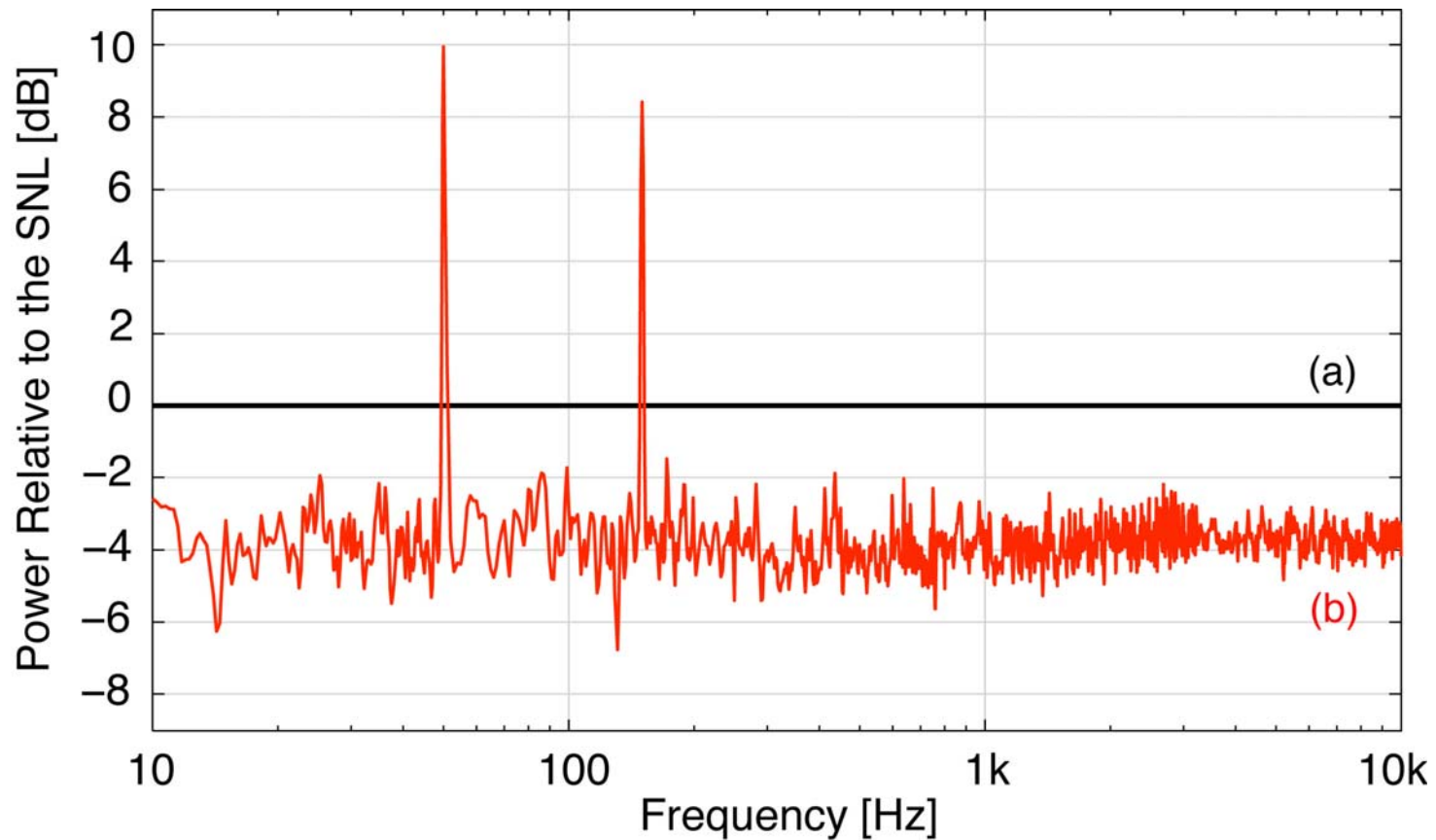
(b) Squeezed noise

(c) Shot noise, double laser power

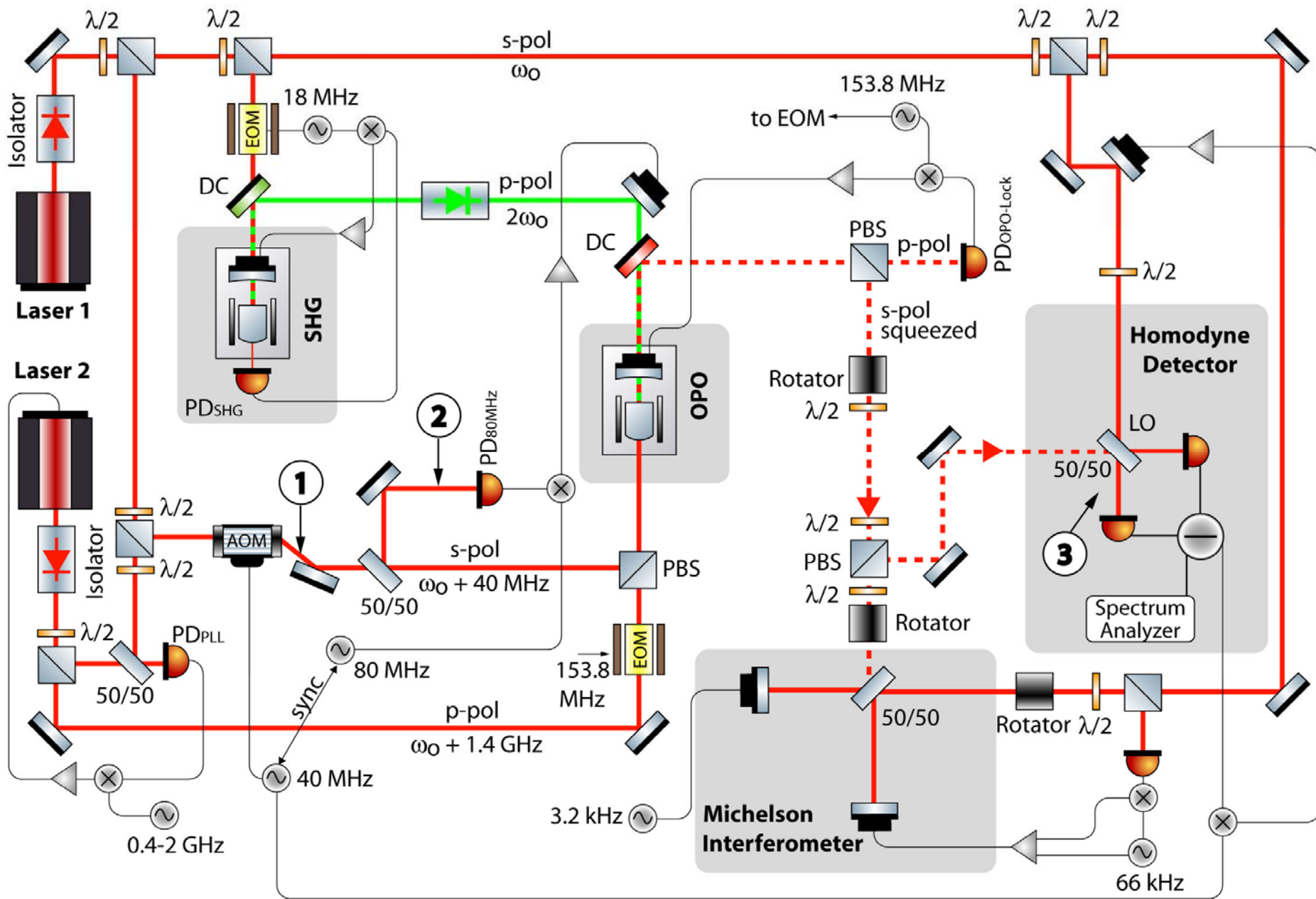
(d) Shot noise, half laser power

[Vahlbruch et al., submitted (2006), available as LSC reviewed manuscript]

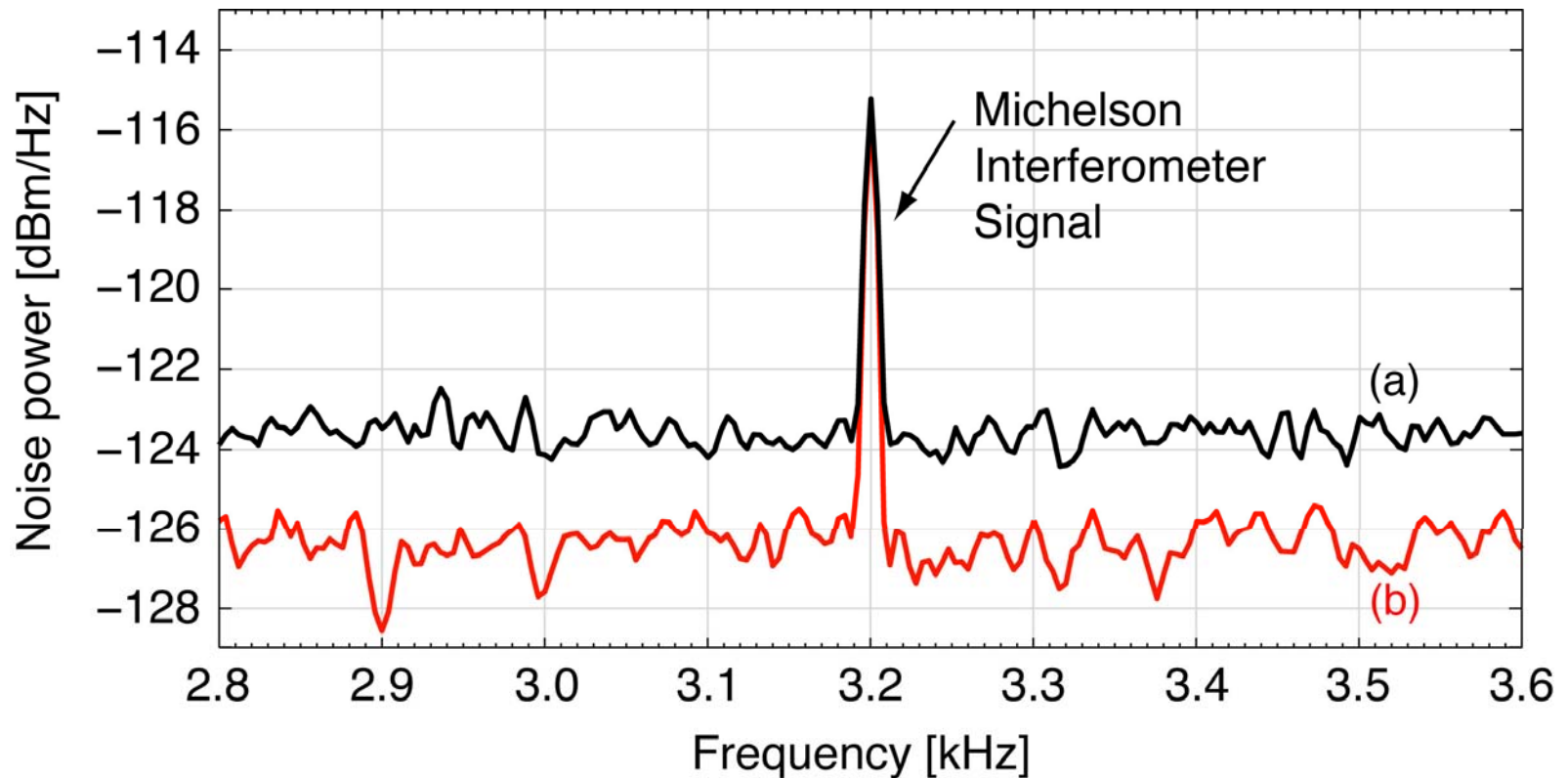
Squeezing in the GW Detection Band



[Vahlbruch et al., submitted (2006), available as LSC reviewed manuscript]



Squeezing in the GW Detection Band



- (a) Shot noise
- (b) Squeezed noise

Summary

Squeezed field injection is fully compatible with detuned signal recycling and a possible control scheme has been demonstrated (in the MHz regime).

A control scheme for squeezed vacuum fields has been demonstrated which enabled the observation of squeezing from 10 Hz to 10 kHz.