

Continuous-variable quantum key distribution: towards implementation in space

Vladyslav Usenko

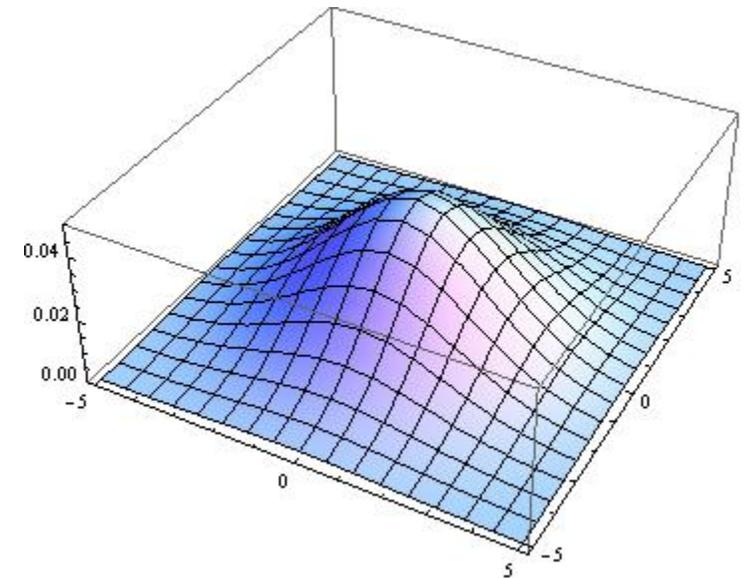
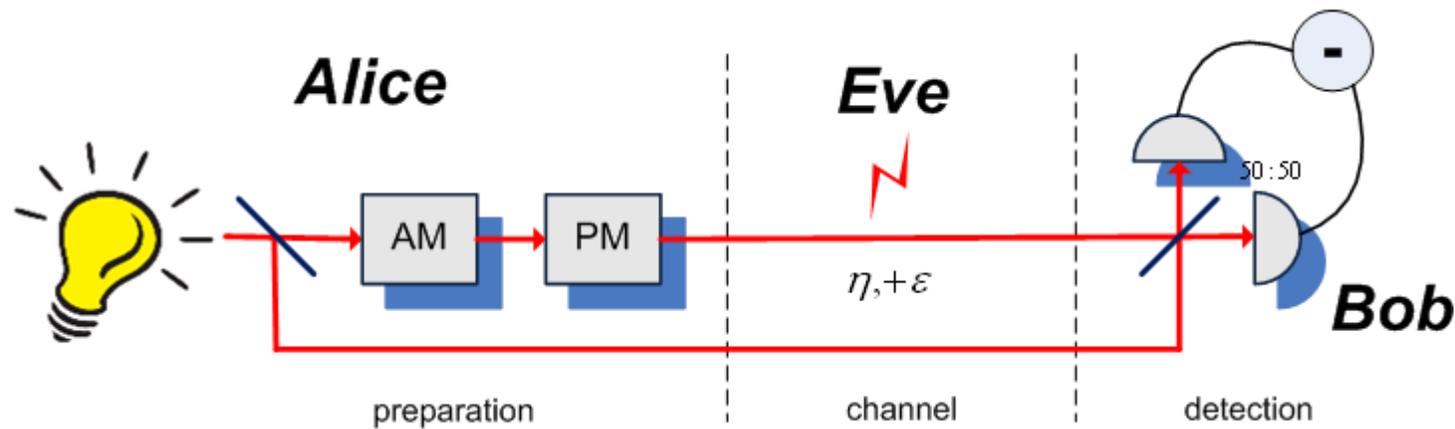


Palacký University
Olomouc

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Continuous-variable quantum key distribution (CV QKD)

- Laser light, homodyne detection
- Amplitude / phase quadrature modulation (Gaussian distributions)



Review: E. Diamanti, A. Leverrier, Entropy, **17**, 6072 (2015)

CV QKD: towards space application

Main alternative: **Discrete-variable QKD**

[DV-CV QKD comparison: M. Lasota, R. Filip, VU, PRA 95, 062312 (2017)]

CV QKD: towards space application

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Advantages of CV QKD:

- Homodyne detection filters out background radiation
- Bright pulses can simplify targeting
- Large encoding alphabet - potentially higher key rates
- Homodyne detection is more feasible

CV QKD: towards space application

Issues for CV QKD

Possible solutions

Necessity of phase locking

CV QKD: towards space application

Issues for CV QKD	Possible solutions
Necessity of phase locking	“Local” local oscillator [E]*

*[PRX 5, 041009 / 041010 (2015)]

[E] – existing solution, [H] – highly probable, [M] – medium probability

CV QKD: towards space application

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Necessity of phase locking

Gaussian modulation - demanding post-processing algorithms

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CV QKD: towards space application

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Gaussian modulation - demanding post-processing algorithms	Non-Gaussian modulation [M]*, development of effective codes [M]**

*[PRL 102, 180504 (2011)]

** [Phys. Rev. A 77, 042325 (2008)]

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CV QKD: towards space application

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CV QKD: towards space application

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Gaussian modulation - demanding post-processing algorithms	Non-Gaussian modulation [M], development of effective codes [M]
Finite-size effects and channel estimation	Optimization of estimation, double modulation [E]*

*[Phys. Rev. A 90, 062310 (2014)]

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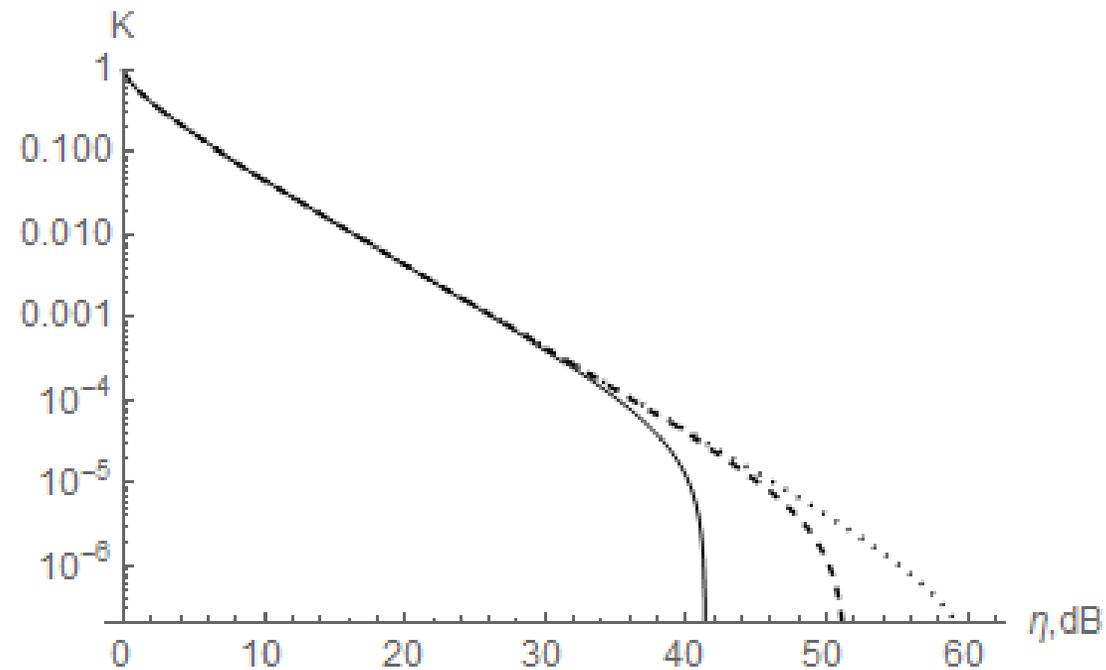
Strong loss and channel fluctuations

Technical improvements [E], use of Gaussian post-selection [H]*, channel binning [E], squeezed states [E]

*[PRA 86, 060302 (2012) / 87, 020303 (2013)]

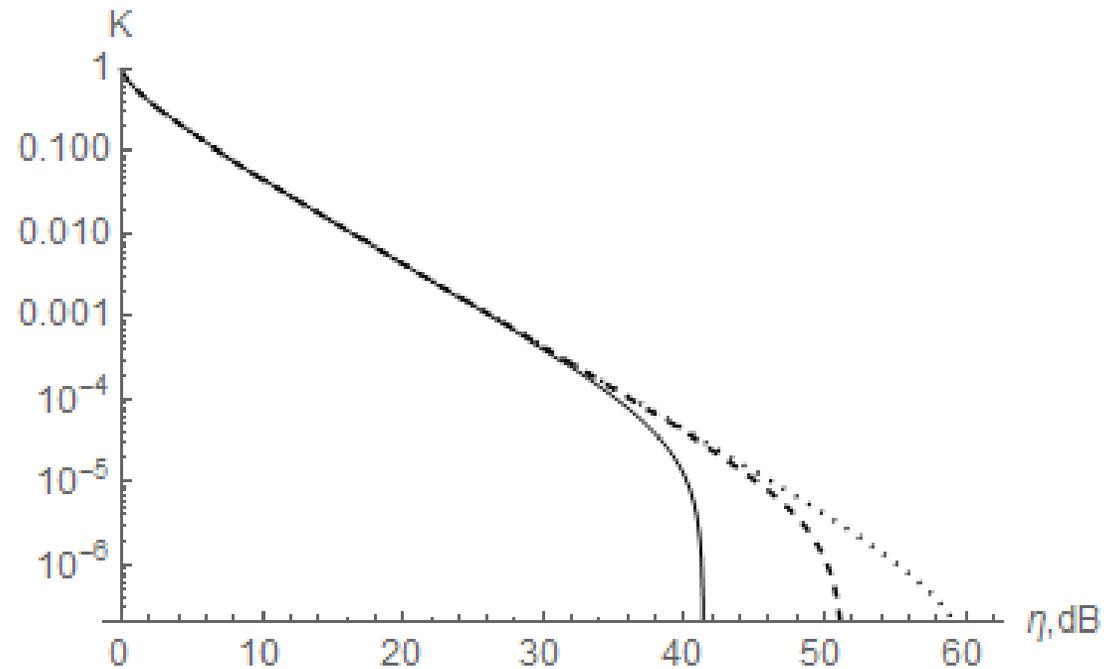
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CV QKD: strong loss and finite-size effects



Key rate as a function of channel loss for different data sizes: $10^{\{12,14,16\}}$ (from left to right) for coherent-state protocol

CV QKD: strong loss and finite-size effects



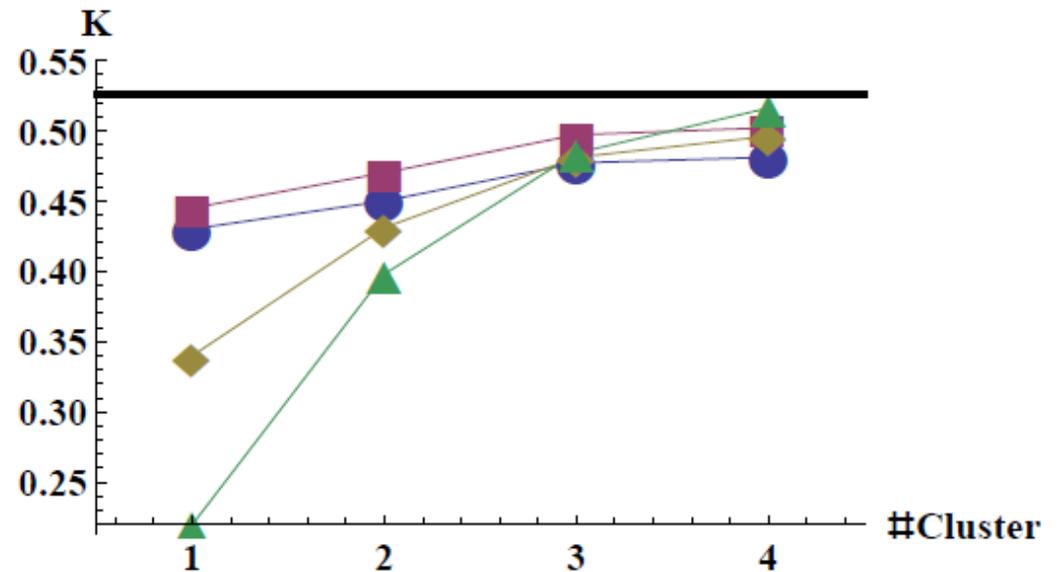
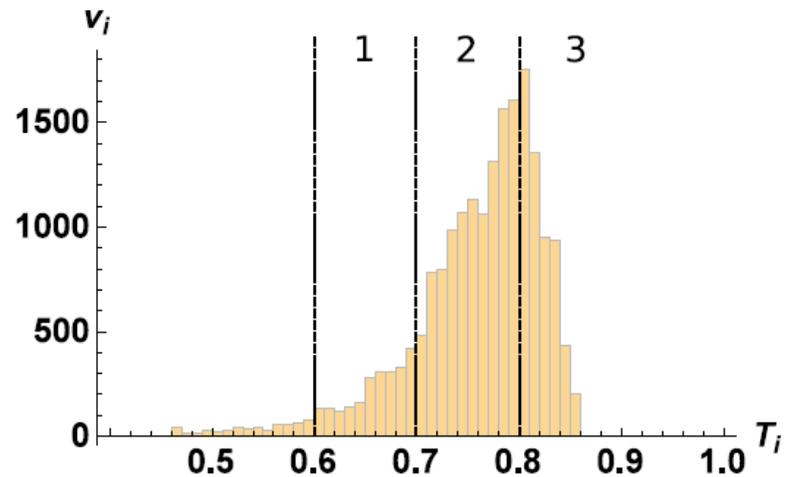
Key rate as a function of channel loss for different data sizes: $10^{\{12,14,16\}}$ (from left to right) for coherent-state protocol

With the use of -3 dB squeezed states roughly the same results are achievable with 1 order of magnitude less data.

CV QKD: channel fluctuations

Atmospheric turbulence causes transmittance fluctuations, which can be harmful for CV QKD [VU et al., NJP 14, 093048 (2012)].

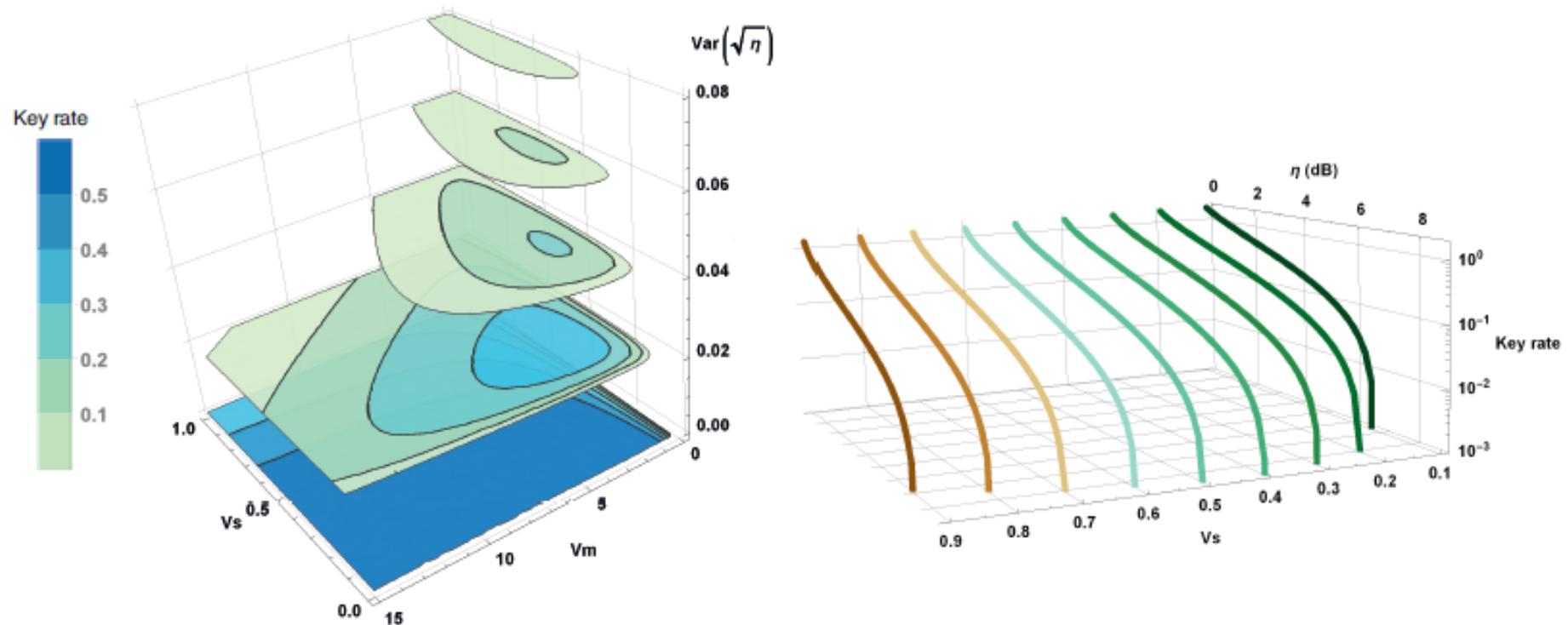
Can be compensated by channel binning



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Can be compensated by channel binning and by signal state squeezing



Outlook

- CV QKD in space is promising
- However it will face several issues
- The set of solutions already exists
- Solutions have to be optimally applied in realistic scenarios

Thank you for attention!

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