Validation of a numerical simulation to study the decoherence of quantum OAM entanglement due to atmospheric turbulence.

A. Hamadou Ibrahim[1,2], Filippus S. Roux[1] and Thomas Konrad[2]

[1] CSIR National Laser Centre, PO Box 395, Pretoria 0001

[2] School of Physics, University of Kwa-Zulu Natal,
Private Bag X54001, Durban 4000

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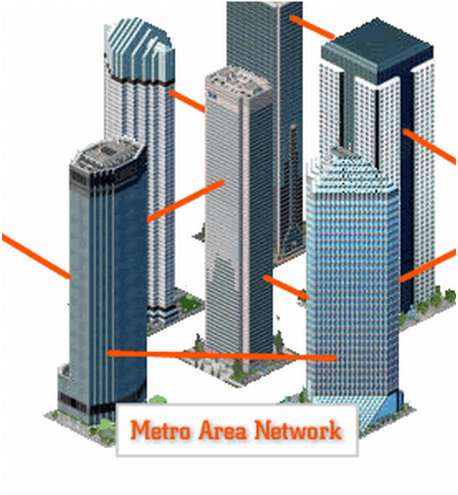
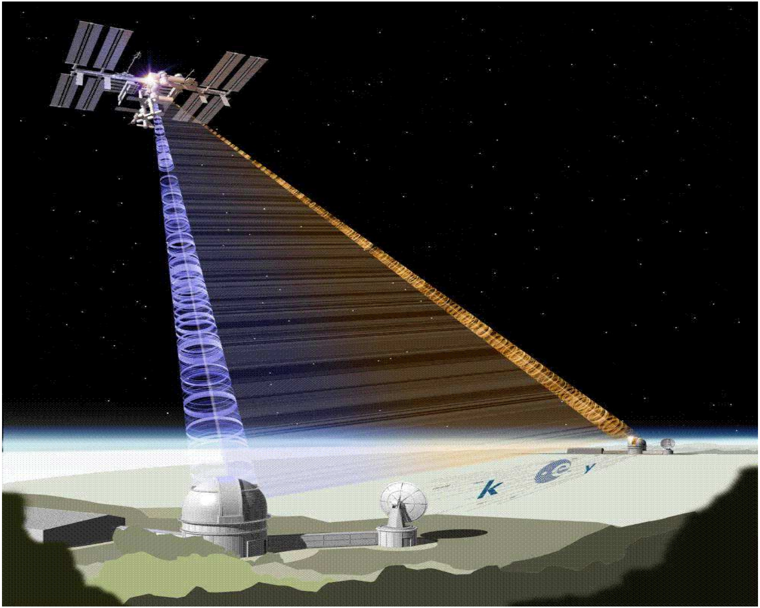
Why quantum communication?

Short distance free-space communication.



Long distance free-space communication.



Challenges for free-space communication.

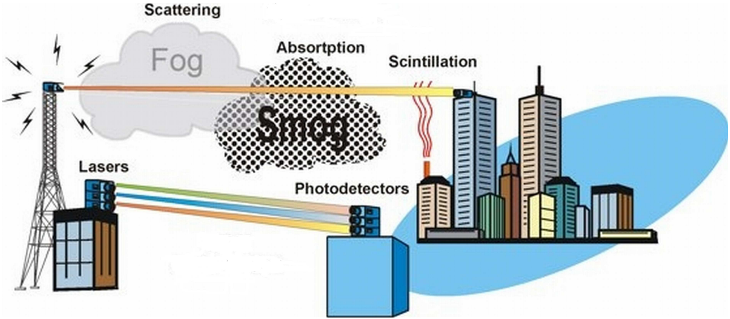
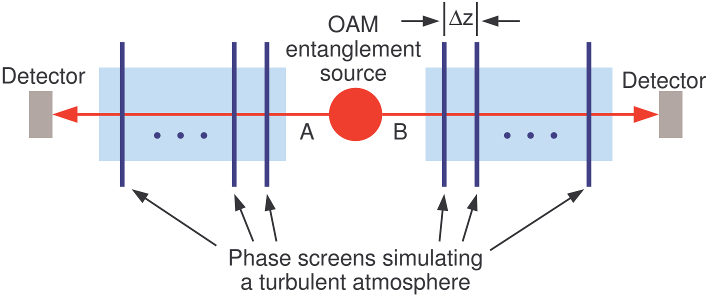


Figure: From the Optical communication dictionary

- And decoherence in the quantum case.

The phase screen method

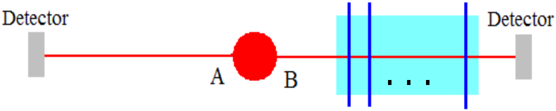


How do we know that we are simulating a quantum system?

T. Konrad, F. de Melo, M. Tiersch, C. Kasztelan, A. Aragao, and A. Buchleitner. *Evolution equation for quantum entanglement*. Nature Phys., 4(4):99, 2008.

$$C\left[(I \otimes \$)|\chi\rangle\langle\chi|\right] = C\left[(I \otimes \$)|\phi\rangle\langle\phi|\right] C(|\chi\rangle),$$

$$|\phi\rangle = (1/2)^{1/2}\left(|1\rangle_A|-1\rangle_B + |-1\rangle_A|1\rangle_B\right)$$



Initial state:

$$|\Psi_{AB}\rangle = (w)^{1/2}|1\rangle_A|-1\rangle_B + (1-w)^{1/2}|-1\rangle_A|1\rangle_B,$$

$$\begin{aligned} |\Psi_{AB}^{out}\rangle &= (1-w)^{1/2}c_1|1\rangle_A|1\rangle_B + w^{1/2}a_1|1\rangle_A|-1\rangle_B \\ &\quad +(1-w)^{1/2}c_{-1}|-1\rangle_A|1\rangle_B + w^{1/2}a_{-1}|-1\rangle_A|-1\rangle_B, \end{aligned}$$

where

$$a_1 = c_1 = \langle 1|\psi\rangle_A; \text{ and } \mathrm{a}_{-1} = \mathrm{c}_{-1} = \langle -1|\psi\rangle_\mathrm{A}$$

$$\rho_i = \kappa \sum_j^N |\Psi_j^i\rangle\langle\Psi_j^i|$$

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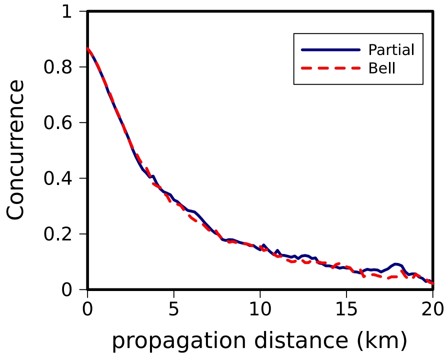
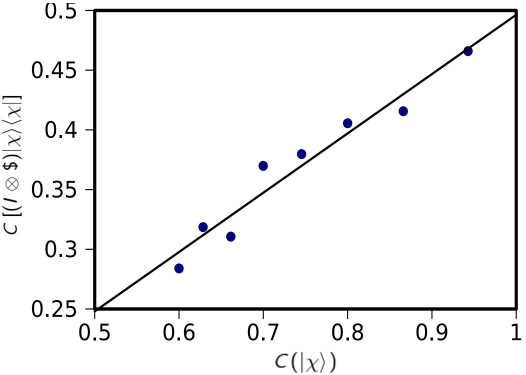


$$C\left[(I\otimes \$)|\chi\rangle\langle\chi|\right] = C\left[(I\otimes \$)|\phi\rangle\langle\phi|\right] C(|\chi\rangle),$$

We used $|\chi\rangle = (1/2)|1\rangle_A|-1\rangle_B + (3/4)^{1/2}|-1\rangle_A|1\rangle_B$.



$$C\,[(I \otimes \$)|\chi\rangle\langle\chi|] = C\,[(I \otimes \$)|\phi\rangle\langle\phi|]\,C(|\chi\rangle) \qquad (1)$$

$$|\Psi_{AB}\rangle = (w)^{1/2}|1\rangle_A|-1\rangle_B + (1-w)^{1/2}|-1\rangle_A|1\rangle_B,$$

with $w = 1/n$ and $n = 3, 4, 5, \cdots 10$.

Thank you for your attention :-)

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