Breathing in and out of Entanglement

http://tph.tuwien.ac.at/∼svozil/publ/2017-Svozil-WOE-pres.pdf

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Brussels, Belgium, EU, Sept 30th, 2017

Questions one could ask

- What is entaglement?
- How can entaglement be produced?
- How can a state “breathe in & out of entanglement?”
- What is the connection between entanglement & “non-locality?”
- Has entanglement a role in measurement?

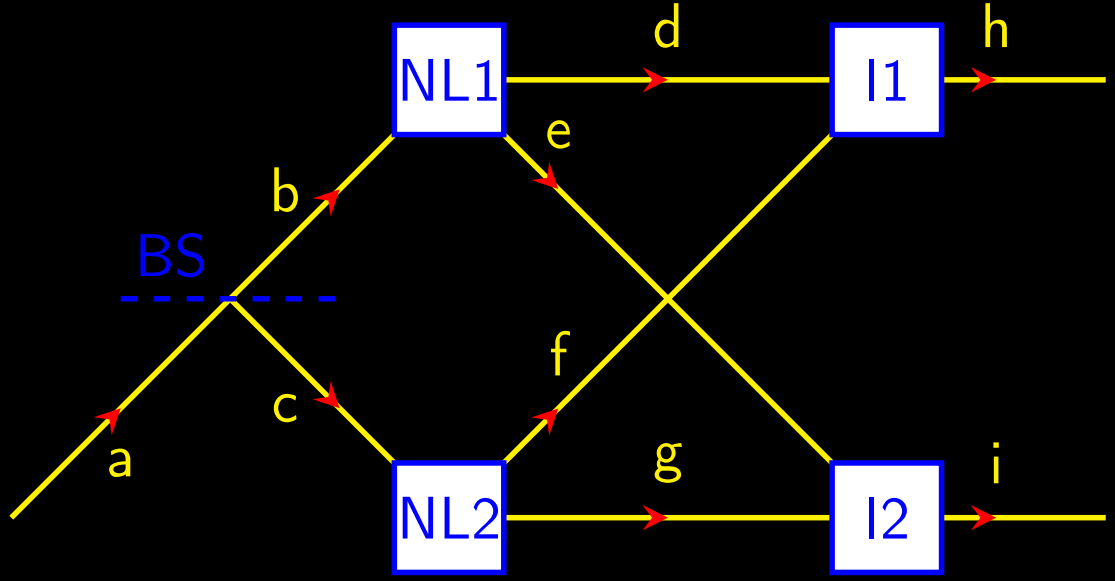
How it all started: Schrödinger on individuation, entanglement and qm object-observer relation

Schrödinger again (cat papers, 1935) wrt entanglement and individuality: *"The whole is in a definite state, the parts taken individually are not."*
German original: *"Das Ganze ist in einem bestimmten Zustand, die Teile für sich genommen nicht."*

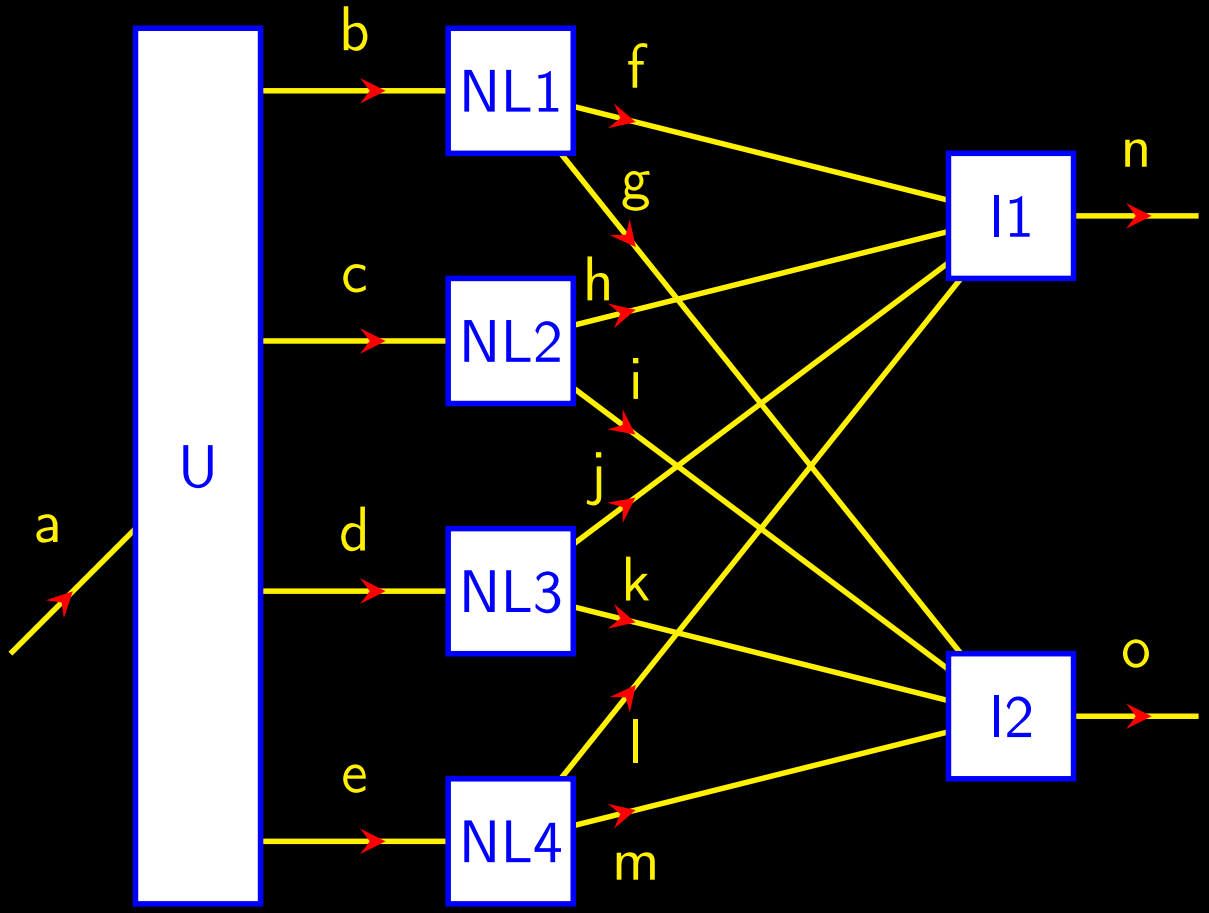
Bennett: *"that you have a complete knowledge of the whole without knowing the state of any one part. That a thing can be in a definite state, even though its parts were not. . . . It's not a complicated idea but it's an idea that nobody would ever think of."*
https://youtu.be/9q-qoeqVVD0

Possible production scheme

Is entanglement nothing but the manifestation of coherent superpositions among (classically mutually exclusive) multipartite states? Eg, Bell basis:



Possible production scheme cntd.



Breathing in & and out of individuality & entanglement

Toy example involving the Cartesian standard basis $(|\mathbf{e}_1\rangle, |\mathbf{e}_2\rangle, |\mathbf{e}_3\rangle, |\mathbf{e}_4\rangle)$ (for individuation) and the Bell basis $(|\Psi^-\rangle, |\Psi^+\rangle, |\Phi^-\rangle, |\Phi^+\rangle)$ (for entanglement). Then,

$$\mathbf{U} = |\Psi^-\rangle\langle\mathbf{e}_1| + |\Psi^+\rangle\langle\mathbf{e}_2| + |\Phi^-\rangle\langle\mathbf{e}_3| + |\Phi^+\rangle\langle\mathbf{e}_4| =$$

$$= (|\Psi^-\rangle, |\Psi^+\rangle, |\Phi^-\rangle, |\Phi^+\rangle) = \frac{1}{\sqrt{2}} \begin{pmatrix} 0 & 0 & 1 & 1 \\ 1 & 1 & 0 & 0 \\ -1 & 1 & 0 & 0 \\ 0 & 0 & -1 & 1 \end{pmatrix}.$$

$$\mathbf{V} = |\mathbf{e}_2\rangle\langle\Psi^-| + |\mathbf{e}_3\rangle\langle\Psi^+| + |\mathbf{e}_4\rangle\langle\Phi^-| + |\mathbf{e}_1\rangle\langle\Phi^+| =$$

$$= \begin{pmatrix} \langle\Phi^+| \\ \langle\Psi^-| \\ \langle\Psi^+| \\ \langle\Phi^-| \end{pmatrix} = \frac{1}{\sqrt{2}} \begin{pmatrix} 1 & 0 & 0 & 1 \\ 0 & 1 & -1 & 0 \\ 0 & 1 & 1 & 0 \\ 1 & 0 & 0 & -1 \end{pmatrix}.$$

$$|\mathbf{e}_1\rangle \overset{\mathbf{U}}{\mapsto} |\Psi^-\rangle \overset{\mathbf{V}}{\mapsto} |\mathbf{e}_2\rangle \overset{\mathbf{U}}{\mapsto} |\Psi^+\rangle \overset{\mathbf{V}}{\mapsto} |\mathbf{e}_3\rangle \overset{\mathbf{U}}{\mapsto} |\Phi^-\rangle \overset{\mathbf{V}}{\mapsto} |\mathbf{e}_4\rangle \overset{\mathbf{U}}{\mapsto} |\Phi^+\rangle \overset{\mathbf{V}}{\mapsto} |\mathbf{e}_1\rangle.$$

Has entanglement a role in measurement?

Suppose through measurement the object & observer (measurement apparatus) interact and become entangled. Then none of them appers to be in a definite state *individually* any longer, even if both of them were in a definite individual state before the measurement. The initial information got re-encoded into relational properties. This was already discussed by von Neumann (1932), Schrödinger (cat papers, 1935) & London and Bauer (1939), among others.


Thank you for your attention!