In this talk I will go over the recent paper by Daniela Frauchiger and Renato Renner, "Single-world interpretations of quantum theory cannot be self-consistent" (arXiv:1604.07422).<br>
The paper introduces an extended Wigner's friend thought experiment, which makes use of Hardy's paradox to show that agents will necessarily reach contradictory conclusions - unless they take into account that they themselves may be in a superposition, and that their subjective experience of observing an outcome is not the whole story.<br>

Frauchiger and Renner then put this experiment in context within a general framework to analyse physical theories. This leads to a theorem saying that a theory cannot be simultaneously (1) compliant with quantum theory, including at the macroscopic level, (2) single-world, and (3) self-consistent across different agents.<br>

In this talk I will (1) describe the experiment and its immediate consequences, (2) quickly review how different interpretations react to it, (3) explain the framework and theorem in more detail.
Daniela Frauchiger & Renato Renner
at Xiv: 1604.07422
2 black
3 white
Pirsa: 16060101

\[ a = 2 h_\text{eff} \]

Alice
\[
\begin{align*}
\ell & \rightarrow 1 \\
\eta & \rightarrow \pm \ell \\
\eta' & \rightarrow 1 + \eta
\end{align*}
\]

Bob
\[
\begin{align*}
b & = 4 + \eta, \eta' \\
\ell' & = \ell + \eta
\end{align*}
\]

Wigner
\[
\begin{align*}
w_A &= 40 \ell f_{\text{Pauli}} \\
10k_A &= 1h >_A - 1k >_B \\
1f_{\text{Pauli}} A &= 1h >_A + 1k >_B
\end{align*}
\]

\[
\begin{align*}
\omega_B &= (1 - 1^> B) / \sqrt{2} \\
\omega_{B'} &= (1 - 1^> B') / \sqrt{2}
\end{align*}
\]
\[ \frac{1}{\sqrt{3}} \left( |h\rangle_A |+\rangle_B + |h\rangle_A |-\rangle_B + |t\rangle_A |-\rangle_B \right) \]

\[ |h\rangle_A |\text{fail}\rangle_B \]

\[ |\text{fail}\rangle_A |-\rangle_B \]
\[ \frac{1}{\sqrt{3}} \left( |\text{fail}_A\rangle + |\text{fail}_B\rangle + \frac{1}{\sqrt{2}} (|\text{fail}_A\rangle + |\text{fail}_B\rangle) \right) \]

\[
= \ldots \frac{1}{\sqrt{2}} |\text{fail}_A\rangle |\text{fail}_B\rangle + \ldots
\]
2 black
3 white

\((*,A,B)\times\)
\((*,W,B)\times\)
\[ Wigner \quad \omega_A = \langle 0k | fail \rangle \]
\[ 10k_A = \frac{1h_A - 1k_A}{\sqrt{2}} \quad \omega_A = 0k \rightarrow b = +1 \]
\[ |fail_A \rangle = \frac{1h_A + 1k_A}{\sqrt{2}} \]
\[ \omega_B = \langle 0k | fail \rangle \]
\[ 10k_B = \frac{1-1 \rangle_B - 1+1 \rangle_B}{\sqrt{2}} \quad \omega_B = 0k \]
\[ |fail_B \rangle = \frac{1-1 \rangle_B + 1+1 \rangle_B}{\sqrt{2}} \]
\[ A \equiv \frac{1}{3} \ln \left( \frac{1}{2} \right) + \frac{1}{3} i t \leq \frac{1}{3} \ln 2 \]

\[ h \rightarrow 1 \rightarrow s = \frac{1 + i t}{\sqrt{2}} \]

\[ t \rightarrow 1 \downarrow \]

\[ a = h \rightarrow w_B = \text{fail} \]

\[ b = s \rightarrow a = h \]

\[ \text{Bob} \quad b = 4 + 3, 1 \|

\[ \{ 1 \uparrow \downarrow, 1 \downarrow \downarrow \}

\[ 1 \overline{1} \]

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\[ |h_A^\uparrow \rangle \rightarrow S + |t_A^\uparrow \rangle \]

Reject QT
- can't measure macro for an, but \( \neq QT \)
- can, but not observers

Reject SW
- more than 1 outcome is "real"

Reject SC
- (ambiguity?)