# Applying quantum discord to quantum information

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# Outline of the paper

- Title: Revival of decohered quantum correlation using weak measurement and quantum measurement reversal (tentative)
- Quantum discord: the definition
  - Entropic discord
  - Geometric discord

# Outline of the paper

- Numerical methods for quantum discord estimation
  - Entropic discord
  - Geometric discord
  - Monte Carlo Sampling
- Experiment
  - A brief discussion of the concurrence result
  - Theoretical estimation of quantum discord under the same scenario

# Outline of the paper

- Result
- Discussion

# Tentative title

- Revival of decohered quantum correlation using weak measurement and quantum measurement reversal

- Any comments?

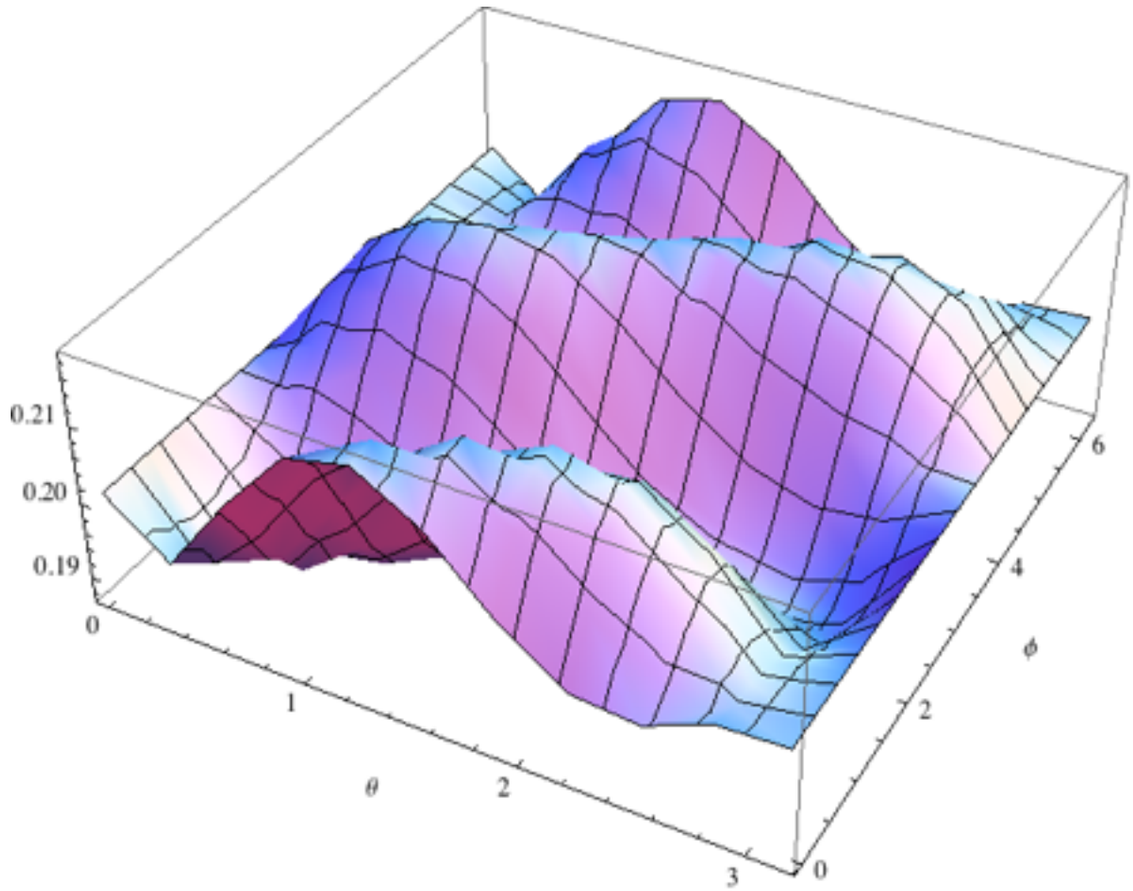
# Quantum discord: the definition

- Entropic discord
  - Compared with the classical information
  - Briefly discusses the A-side, B-side disagreement
- Geometric discord
  - Focuses on the intuitive picture
  - Briefly discusses on the Hilbert-Schmidt 1-norm and the 2-norm

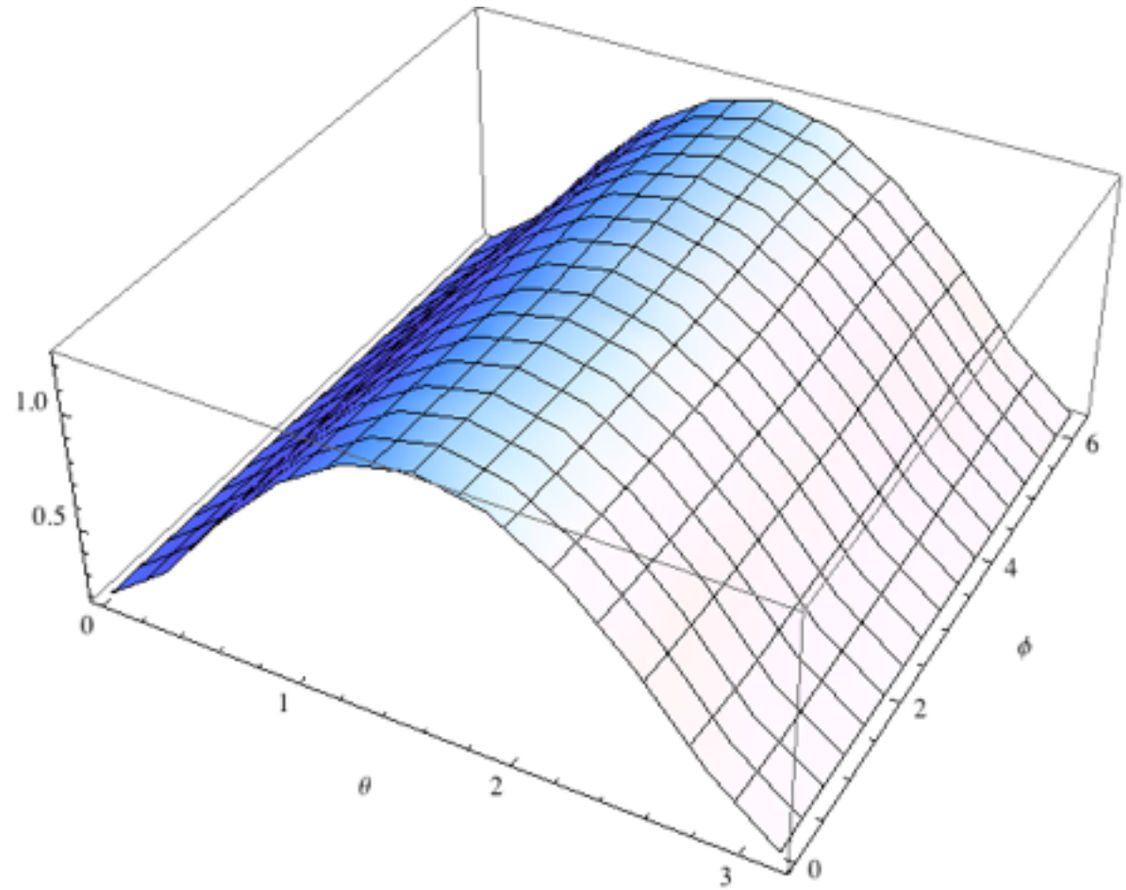
# Numerical method for quantum discord estimation

- Two-qubit quantum discord
  - Entropic discord and geometric discord
  - Searching over the Bloch sphere (θ and ϕ)

$$\rho = \begin{pmatrix} 0.540602 + 0.\,i & 0.0411092 + 0.0278291\,i & -0.0272953 - 0.000610956\,i & 0.0762992 + 0.470501\,i \\ 0.0411092 - 0.0278291\,i & 0.00962878 + 0.\,i & 0.000789579 + 0.000358169\,i & 0.0306976 + 0.0207185\,i \\ -0.0272953 + 0.000610956\,i & 0.000789579 - 0.000358169\,i & 0.00403418 + 0.\,i & -0.00196174 - 0.0290409\,i \\ 0.0762992 - 0.470501\,i & 0.0306976 - 0.0207185\,i & -0.00196174 + 0.0290409\,i & 0.445735 + 0.\,i \end{pmatrix}$$




Entropic discord



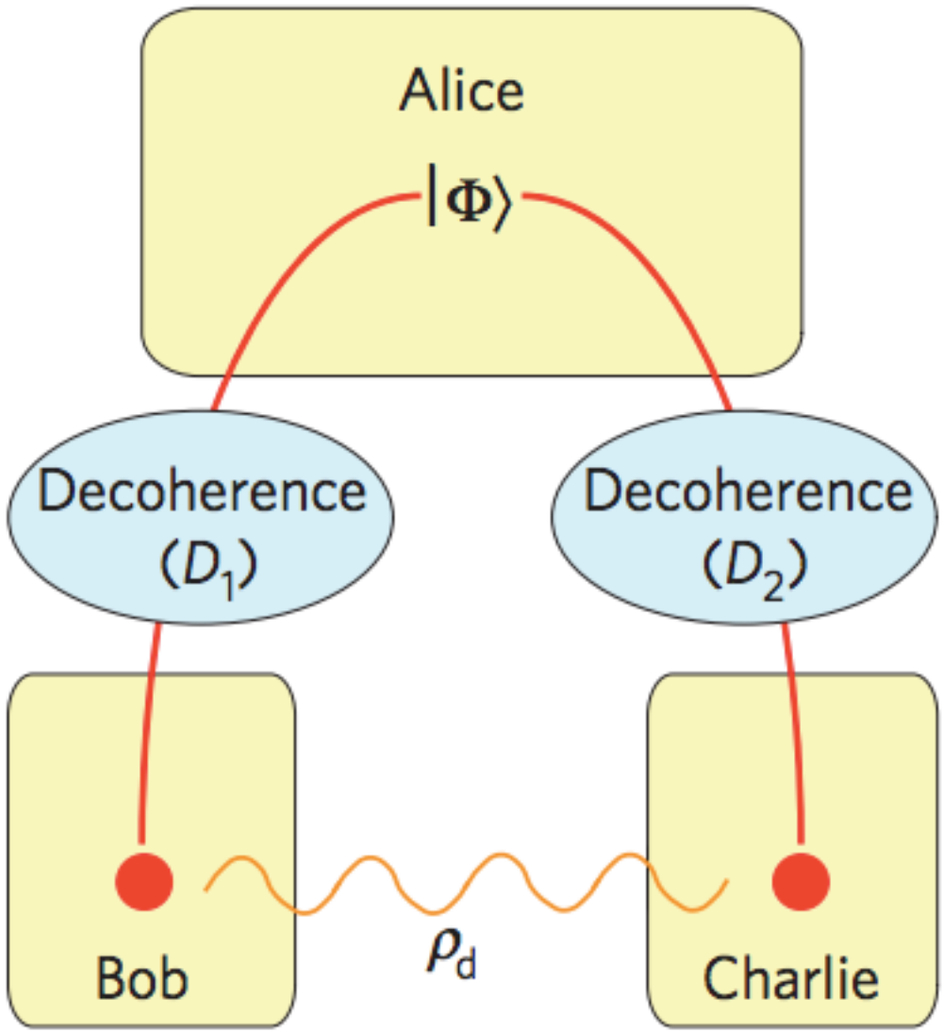

Geometric discord

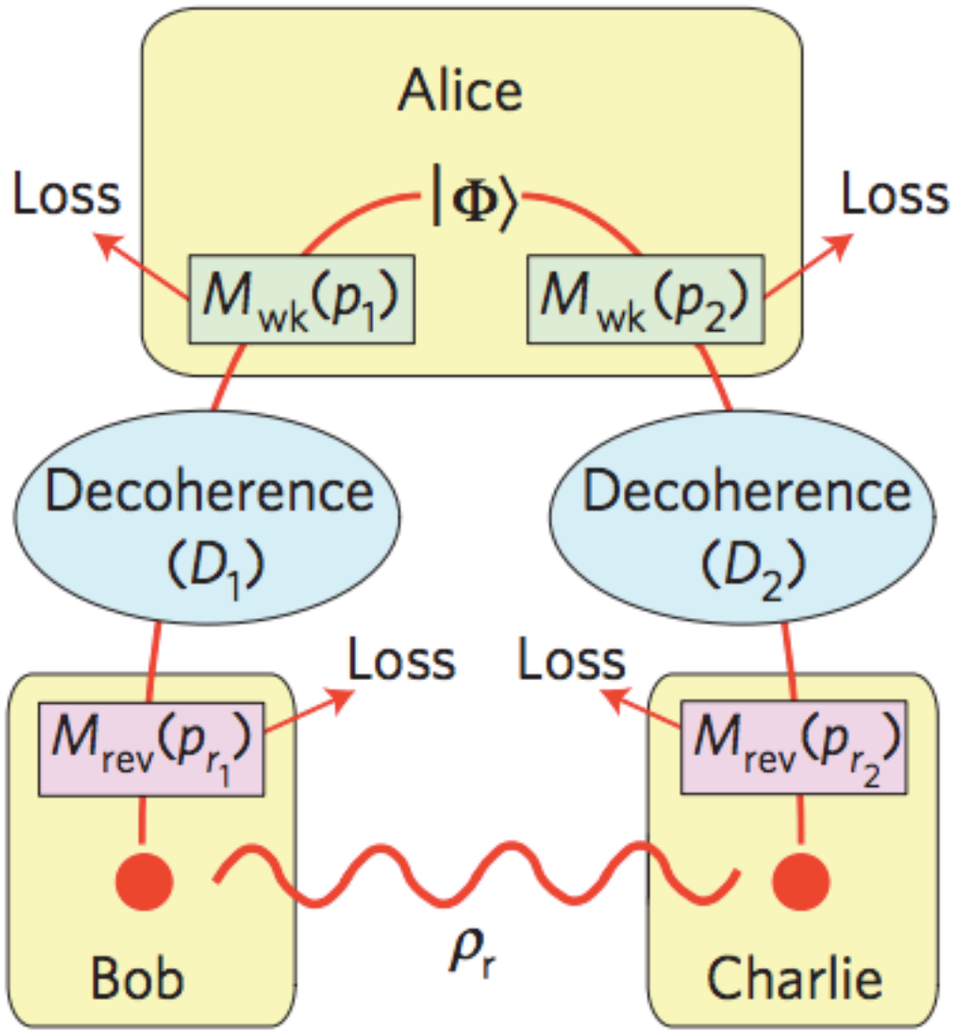
# Numerical method for quantum discord estimation

- General quantum discord
  - Monte Carlo Sampling in the generalized Bloch sphere

# Experiment

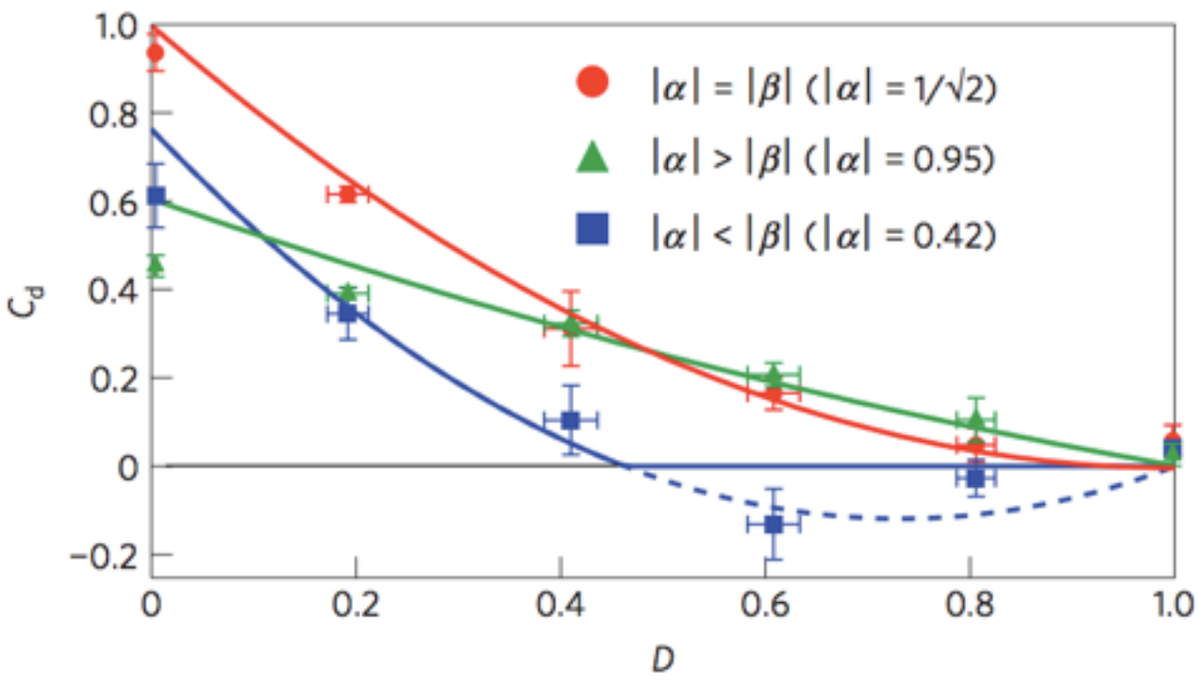
- Experimental description
  - Reproduced from Kim *et al.*

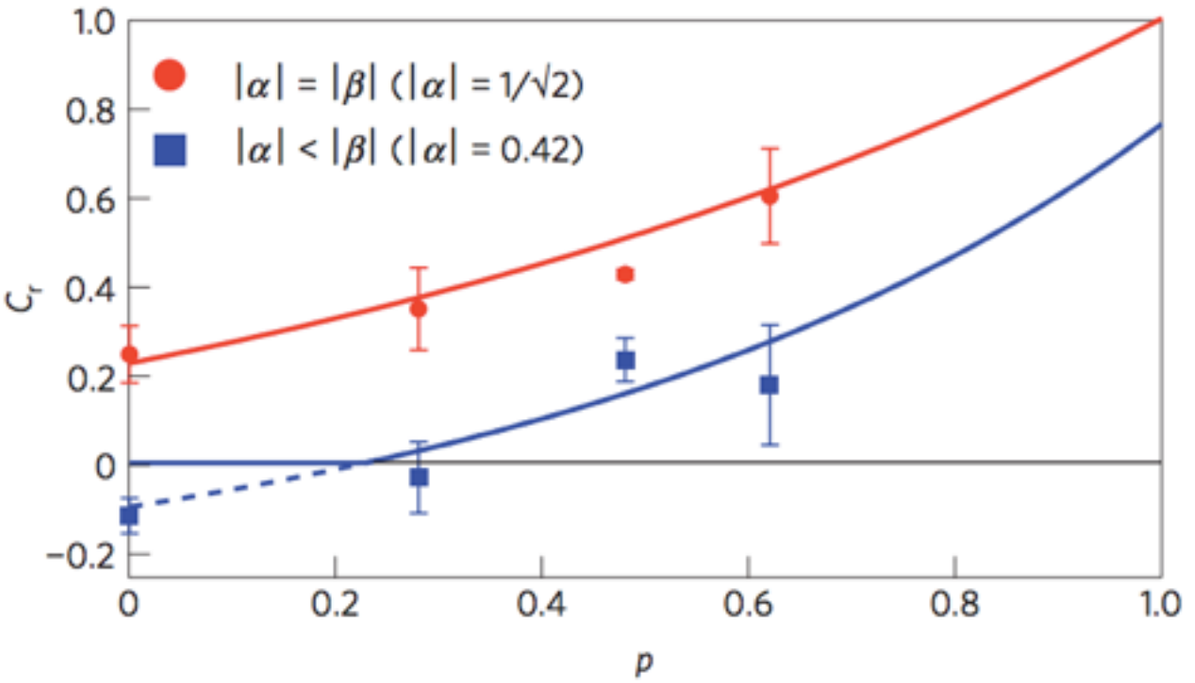

Alice
$|\Phi\rangle$
Decoherence ($D_1$)
Decoherence ($D_2$)
Bob
$\rho_d$
Charlie


Alice
Loss
$|\Phi\rangle$
Loss
$M_{wk}(p_1)$
$M_{wk}(p_2)$
Decoherence ($D_1$)
Decoherence ($D_2$)
Loss
Loss
$M_{rev}(p_{r_1})$
$M_{rev}(p_{r_2})$
Bob
$\rho_r$
Charlie

# Experiment

- A brief discussion of the concurrence result
  - Reproduced from Kim *et al.*

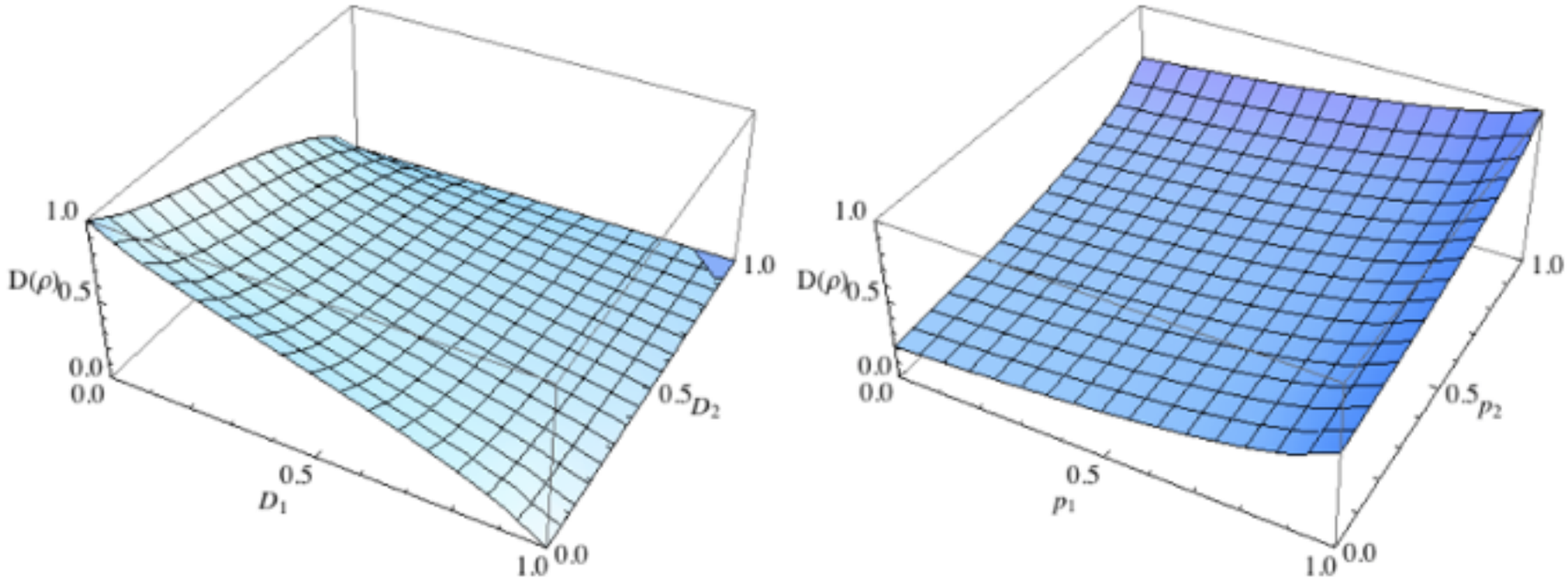

1.0
0.8
0.6
0.4
0.2
0
−0.2
$C_d$
0
0.2
0.4
0.6
0.8
1.0
$D$
$|\alpha| = |\beta|$ ($|\alpha| = 1/\sqrt{2}$)
$|\alpha| > |\beta|$ ($|\alpha| = 0.95$)
$|\alpha| < |\beta|$ ($|\alpha| = 0.42$)


1.0
0.8
0.6
0.4
0.2
0
−0.2
$C_r$
0
0.2
0.4
0.6
0.8
1.0
$p$
$|\alpha| = |\beta|$ ($|\alpha| = 1/\sqrt{2}$)
$|\alpha| < |\beta|$ ($|\alpha| = 0.42$)

# Experiment

- Theoretical estimation of quantum discord under the same scenario

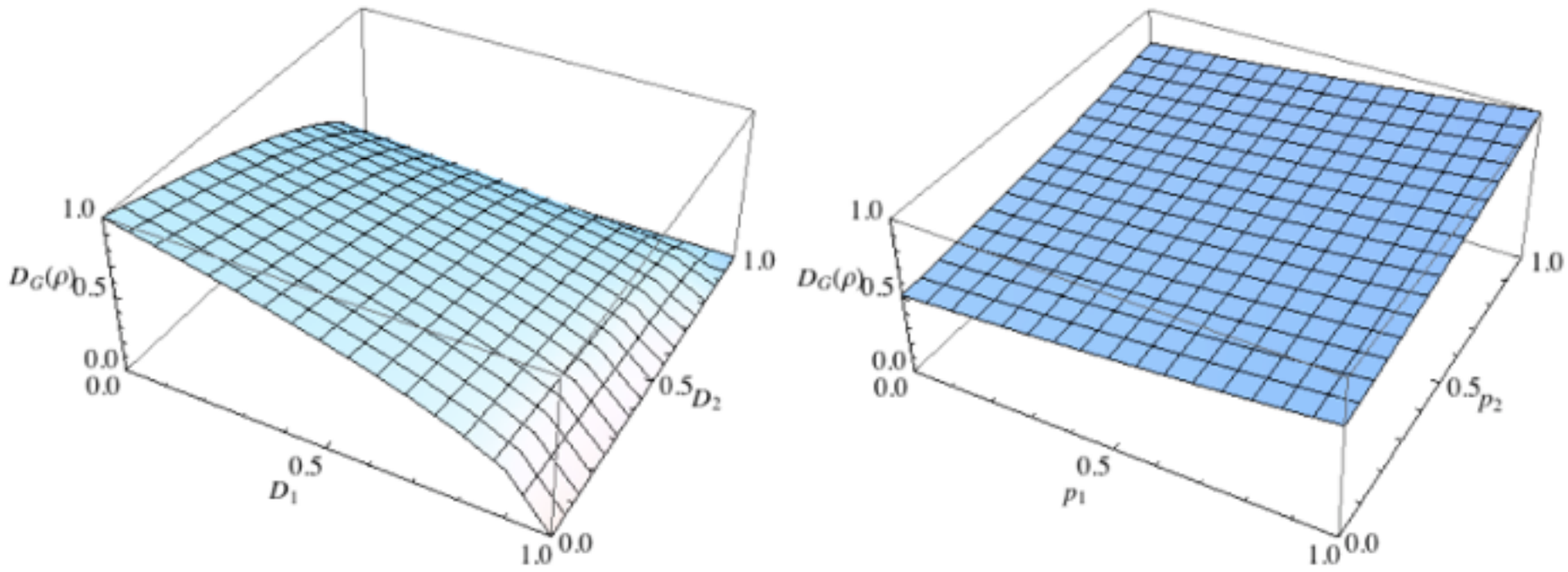
  - Varying $D_1$, $D_2$ and $p_1$, $p_2$ for both entropic and geometric discords




(a) |α| = |β| (b)

(c) |α| < |β| (d)

Entropic discord



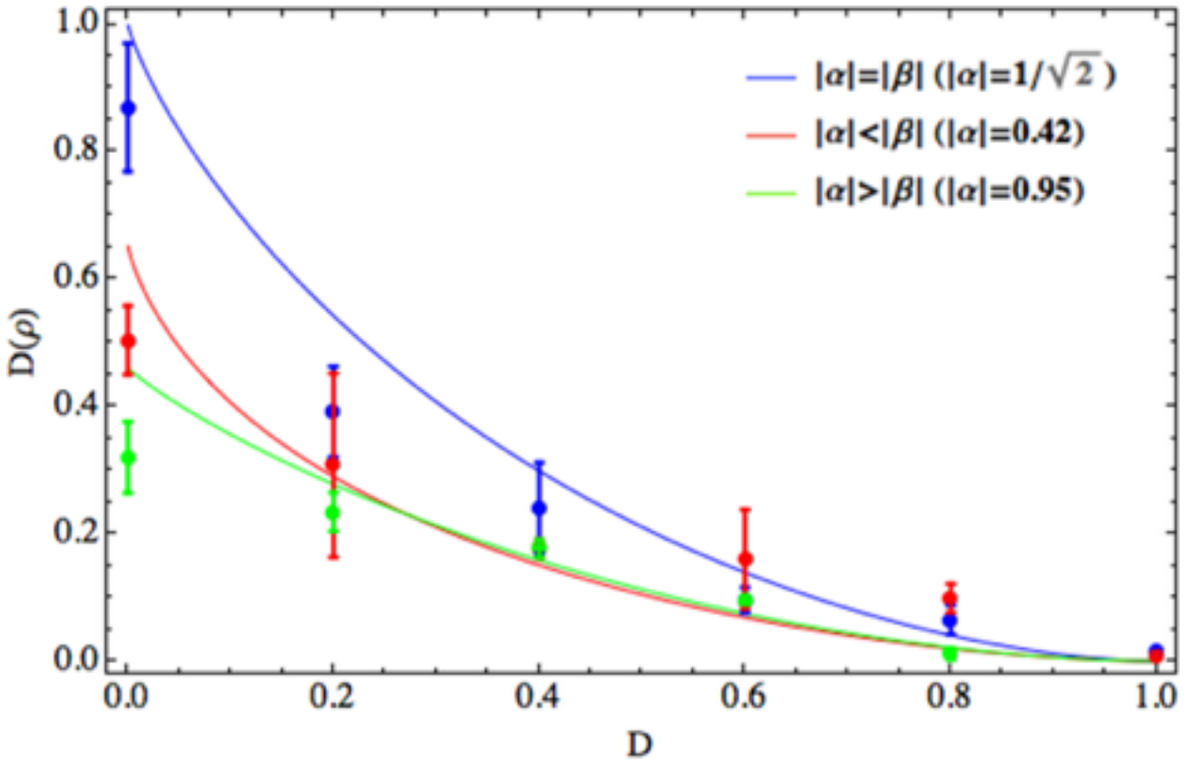

(a) $|\alpha| = |\beta|$ (b)

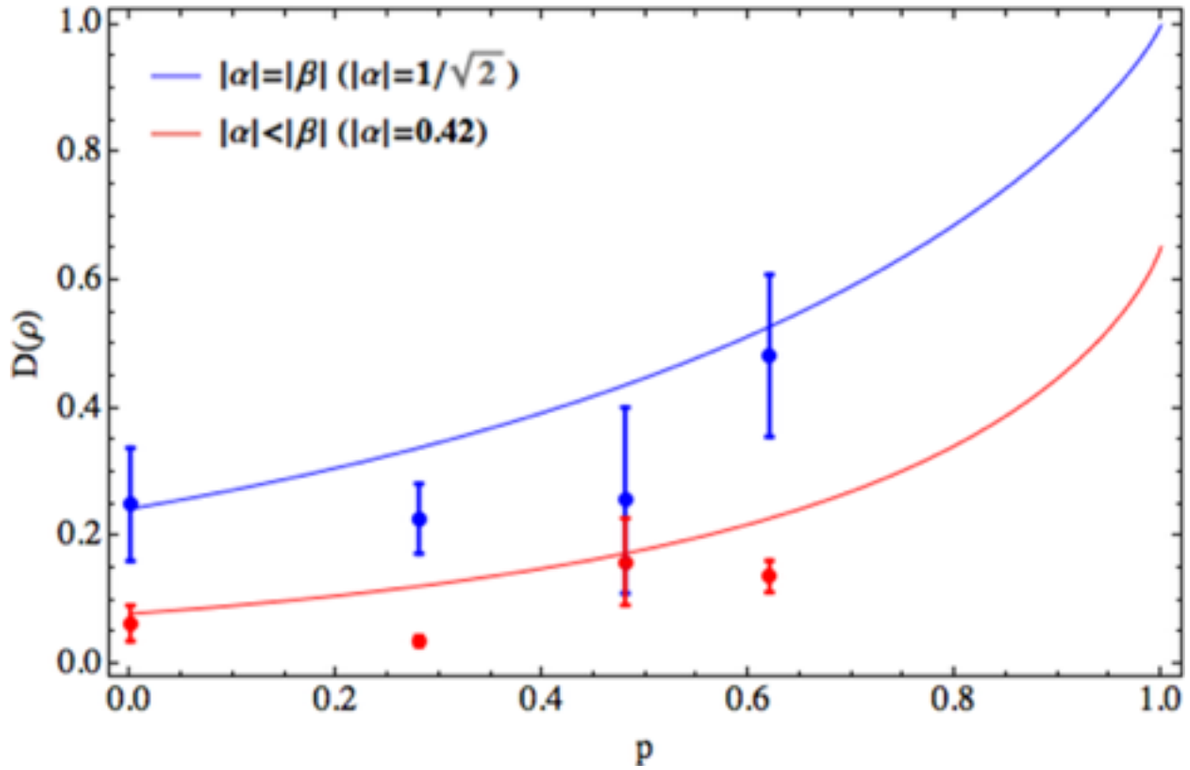
(c) $|\alpha| < |\beta|$ (d)

Geometric discord

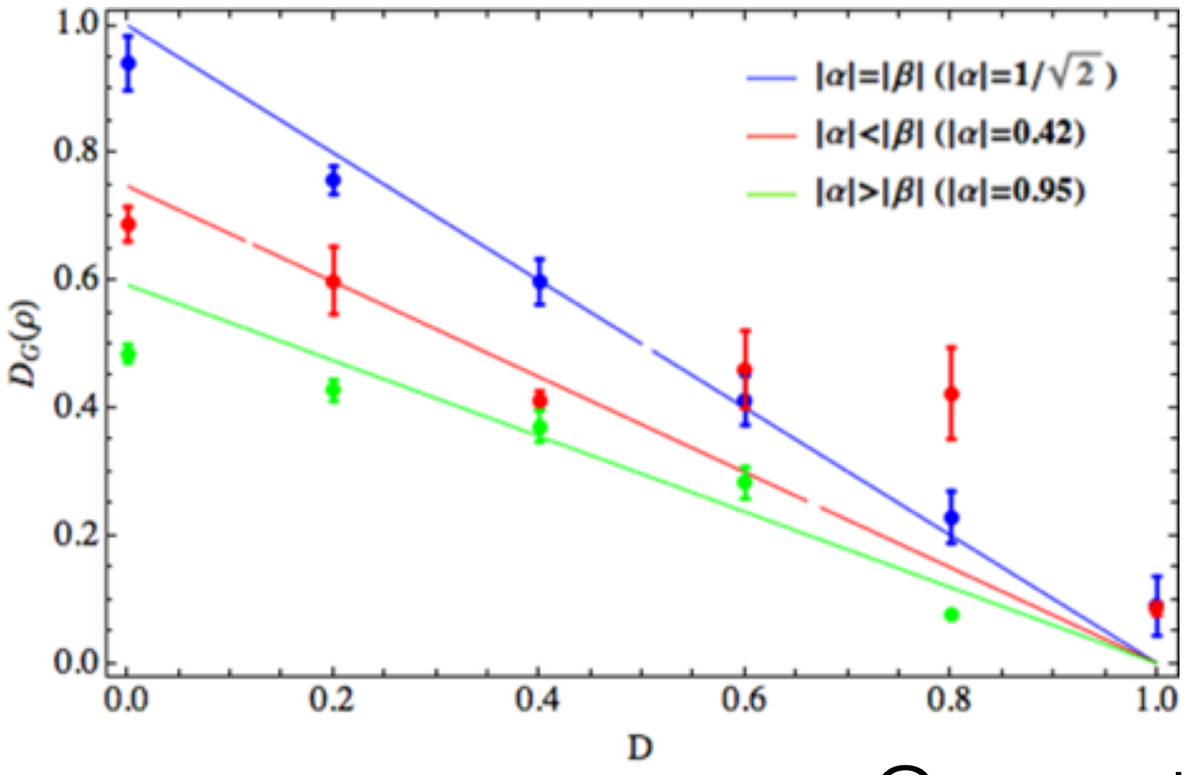
# Result and discussion

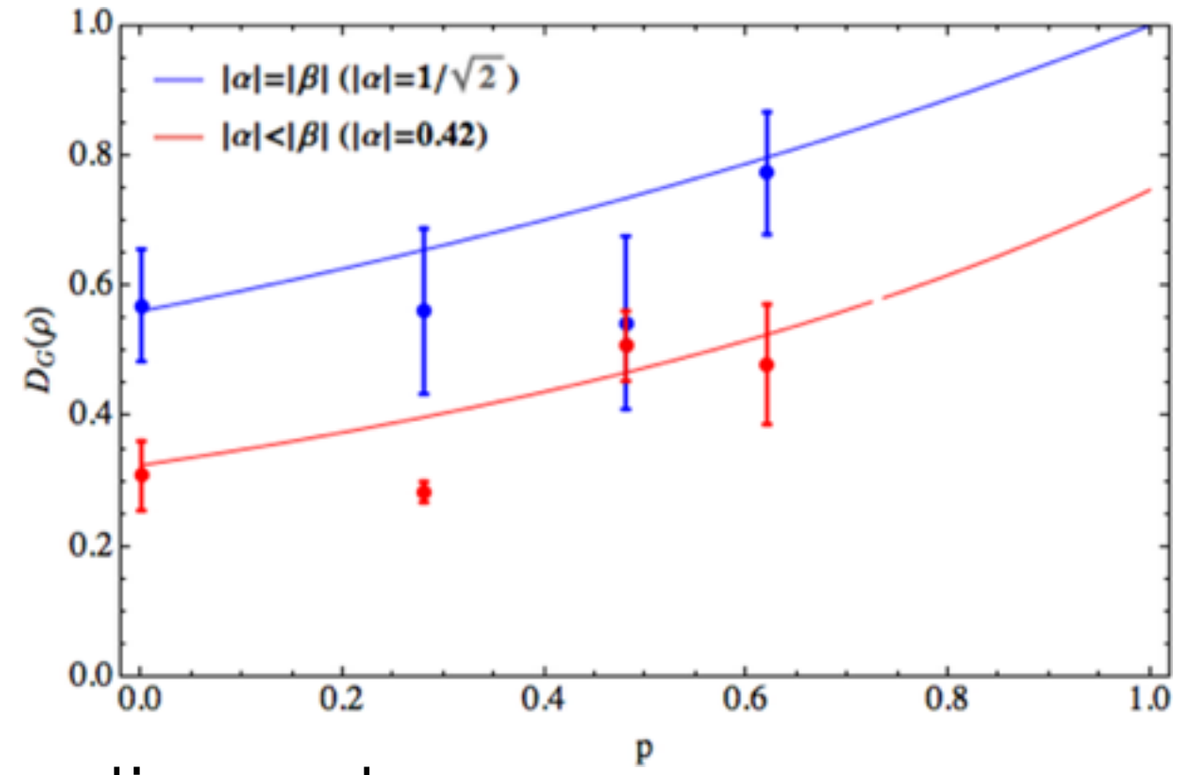
- Very similar to Kim *et al*.
  - Entanglement —> quantum correlation
  - Concurrence —> quantum discord
- I need to say something more interesting.




Entropic discord




Geometric discord