# Quantum Pseudo-Telepathy
## The Magic Square Game

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## 1 Introduction

Telepathy, the ability of transmitting information from one person's mind to another's, would certainly come in handy in many situations, right? Unfortunately (or not), (to the best of our knowledge) telepathy is not a thing. At least, not according to classical physics. Certain aspects of the quantum realm, however, provide a way of communication that for a layman looks as magical as "true" telepathy. This phenomenon is called quantum *pseudo-telepathy* [1].

Quantum pseudo-telepathy is observed in many contexts, usually described in the format of a game: the "impossible colouring games" [1, 3]; the parity games, in which $n \geq 3$ players are given bit-strings and, without communicating to each other, they output one of their bits, winning if their outputs combined obey certain parity conditions [1, 4]; the Deutsch-Jozsa games, where Alice and Bob are given bit strings $x$ and $y$, and must output bit strings $a$ and $b$ such that $a = b$ if and only if $x = y$ [1, 2]; and, the Magic Square game [1, 4]. None of these games admit a classical winning strategy (i.e. is not possible to always win), yet they can be won systematically, without any communication, provided that the players share prior entanglement [1].

In this project, we shall explore the Mermin-Peres Magic Square game. The origins of this game date back to the ninities. It was first described — albeit not in the format of a game — in the works of Mermin [**mermin:1990**] and of Peres [**peres:1990**]. Their results provided (as per the title of Mermin's review letter) a simplied proof for the Kochen-Specker theorem [**Kocher1975**]. Later, in 2002, Aravind demonstrated how to transform Mermin-Peres's proof of then Kochen-Specker theorem into a proof of Bell's theorem [**aravind:xxx**]. Bell's theorem shows the incompatibility of hidden variables (i.e. determinism) and locality, whereas Kochen-Specker's theorem demonstrates the conflicting nature of determinism and non-contextuality. These sort of results may seem challenging, but their descriptions can be greatly simplified by modeling them as quantum games. In particular, it is extremely easy to show that there cannot be a classical solution to the the Magic Square game, and to convince an observer that something "magical" (classically impossible) is happening in a successful implementation of a quantum winnin strategy [1].

*Outline of this paper.*

## 2 Non-Locality and Contextuality

## 3 Quantum Pseudo-Telepathy

## 4 The Magic Square Game

### 4.1 Classical Solution

### 4.2 Quantum Solution

## 5 Quantum Unitaries (? research)

## References

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