

High-Dimensional Semi-Quantum Cryptography

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Objectives

Can we have unconditional communication security with limited quantum resources?

- Bridge the gap between classical and quantum realm.
- Use less expensive quantum hardwares.
- Fallback option for fully-fledged quantum key distribution.

Motivation

- Unconditional security is impossible with all-classical capabilities but possible with quantum resources.
- High-dimensional QKD offers better protection.
- Using HD-resources in SQKD provides advantages.

What is Quantum Key Distribution

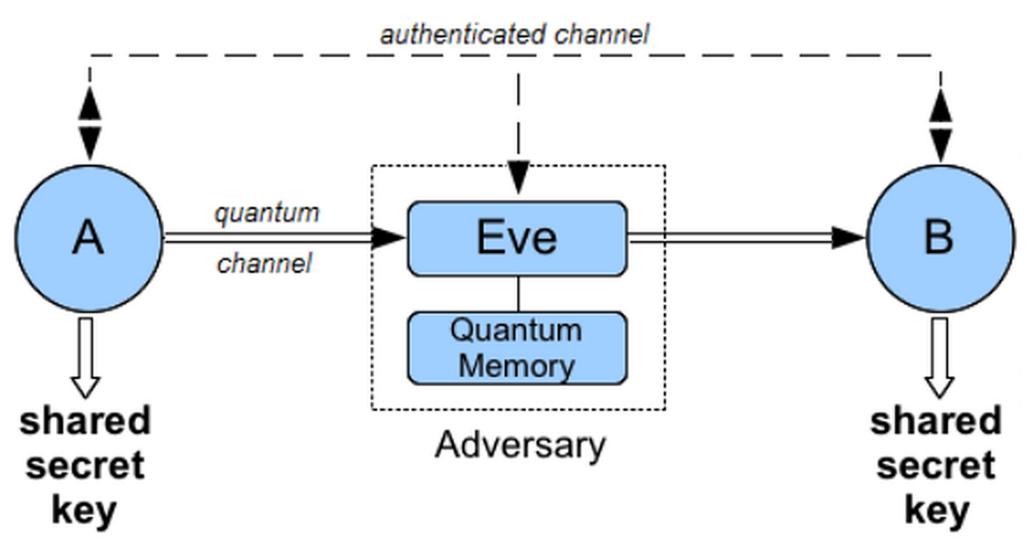


Figure: Quantum Key Distribution

- Alice sends her friend Bob information via qubit through quantum channel.
- Adversary Eve can attack the channel in various ways.
- Alice and Bob communicates classically to produce a shared key.
- The key is secure as long as Eve does not know 'too much' about it compared to Bob.

What is High-Dimensional SQKD

- High-Dimensional qudits instead of traditional qubits.
- More information transmitted in each iteration.
- Robust against quantum cloning.
- Better noise resistance.

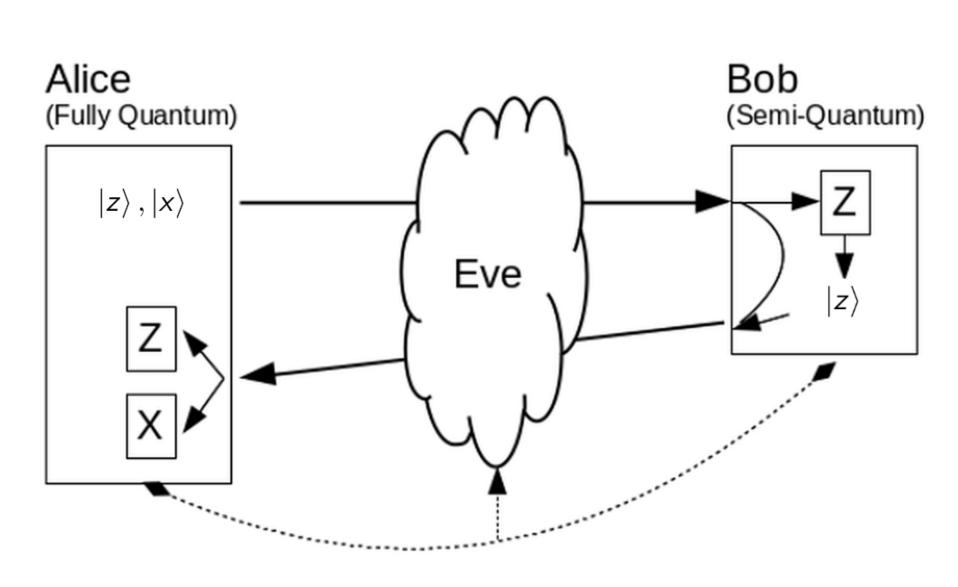


Figure: High-dimensional SQKD

Reduction Process

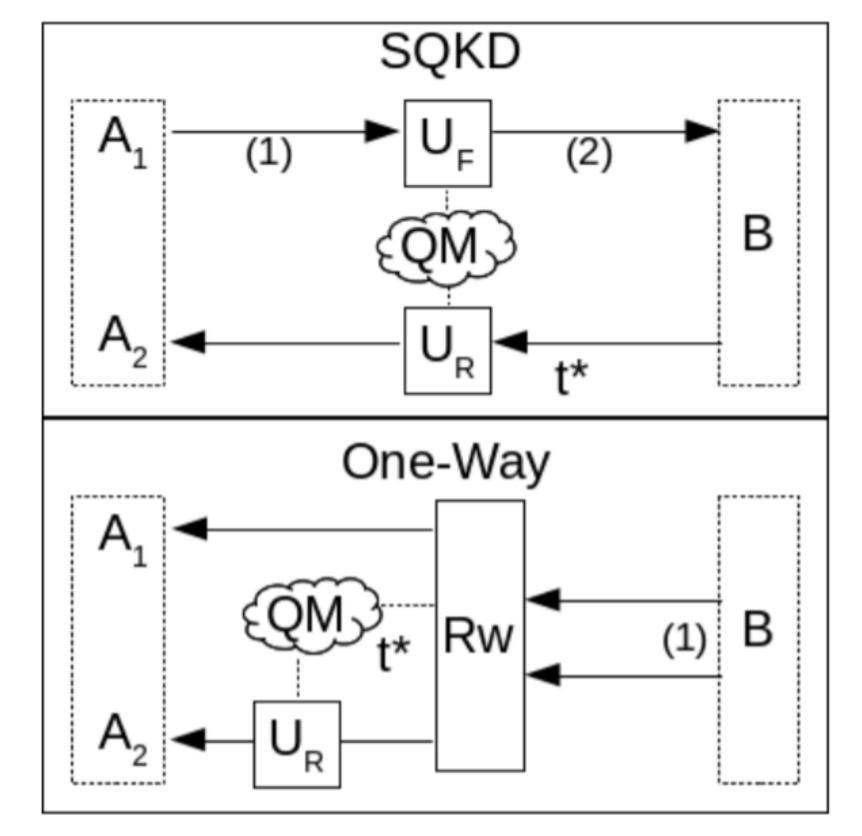


Figure: Convert two-way attack to one-way using a special attack operator ${\cal R}_w$

Important Result

High-dimensional SQKD offers the best key-rate so far. Proof simplification technique developed here is applicable to other quantum key distribution protocols.

Simplified Protocol

HD-SQKD

ing qubits.

5. Alice measures return-

1. Alice prepares $ z\rangle$ or	1. Bob prepares and sends
$ x\rangle$, sends to Bob.	two different states based
	on measure-resend or re-
	flect.
2. Eve attacks the forward	2. Eve attacks only once.
channel.	
3. Bob measure-resends or	3. Alice measures in two
reflects.	basis.
4. Eve attacks the reverse	
channel.	

OW-SQKD

Evaluation

- Noise tolerance: How much disturbance in the channel can the protocol withstand.
- How does it compare to a famous fully quantum HD-QKD protocol.

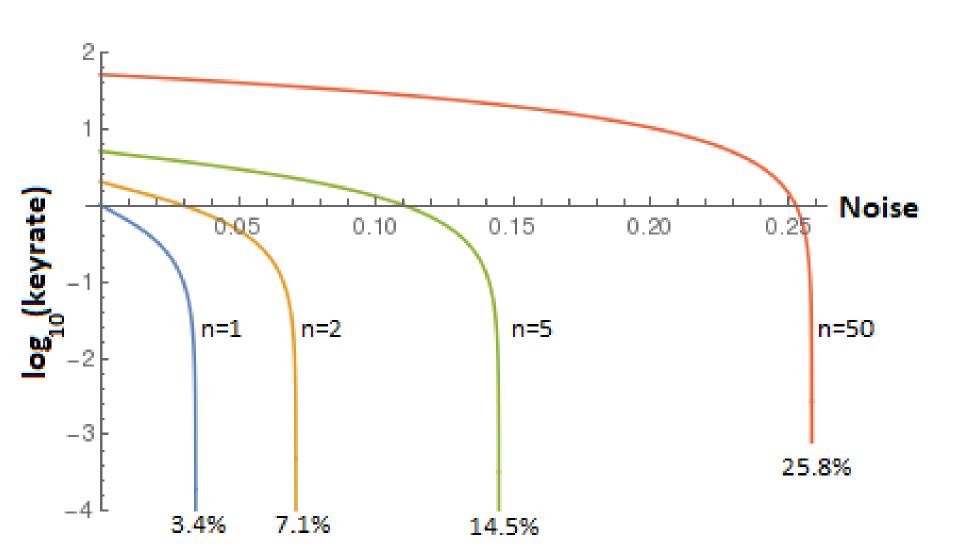


Figure: Noise Tolerance in different dimensions

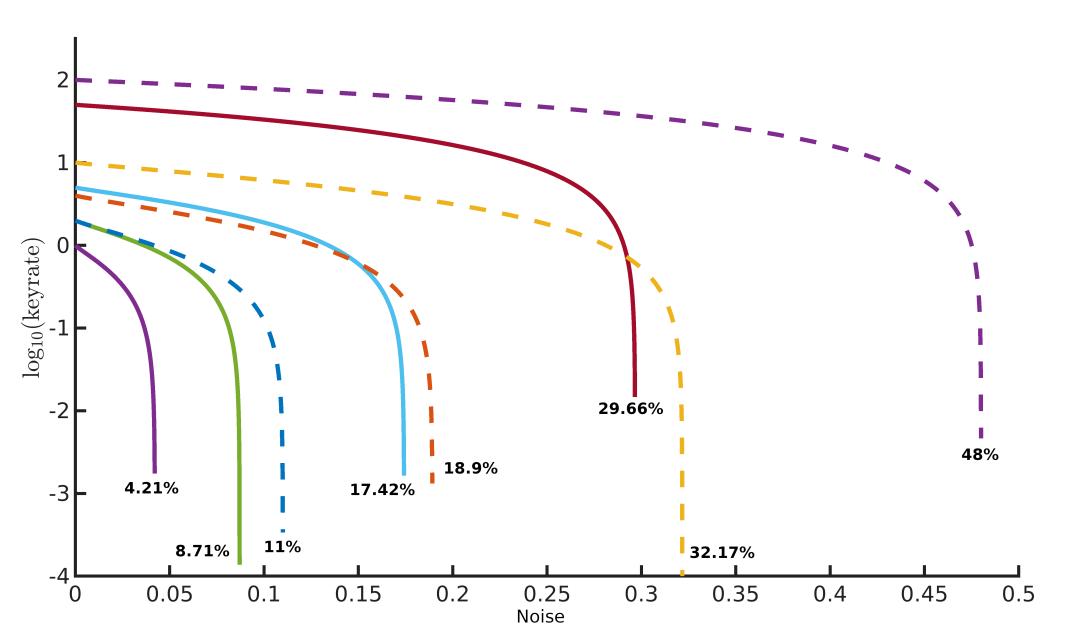


Figure: Noise vs Key rate: HD-SQKD vs HD-BB84

Conclusion

- We have proposed a new HD-SQKD protocol.
- Performed an information-theoretic security analysis.
- Showed how to reduce a two-way protocol to one way.
- Proved that qudits can indeed benefit SQKD model.
- Applying this proof technique to other protocols would be quite interesting.

References

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