

Efficiency of Graphene Spin-logic

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INTRODUCTION

Transistors

- Gates that can block or allow electron flow
- Value of either 0 or 1
- Number of transistors determine performance
- Mostly made up of Silicon

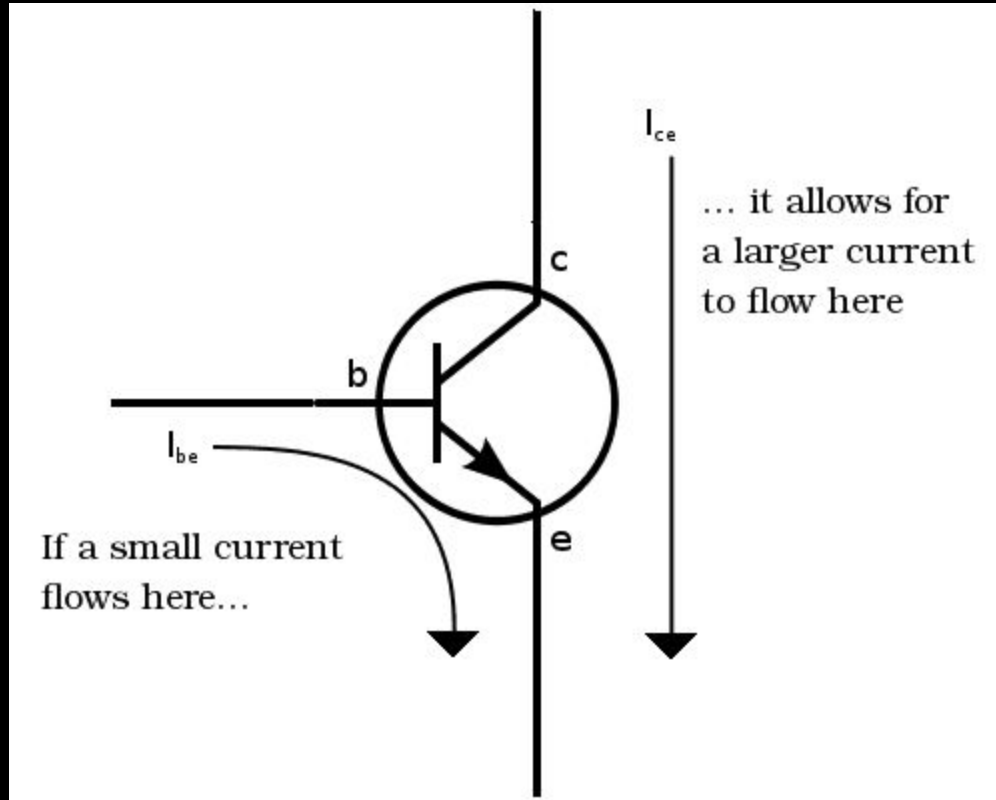


Figure 1. Transistor Diagram

Moore's Law

- Number of transistors in a circuit doubles about every two years
- Observed by Gordon Moore, co-founder of Intel, in 1965

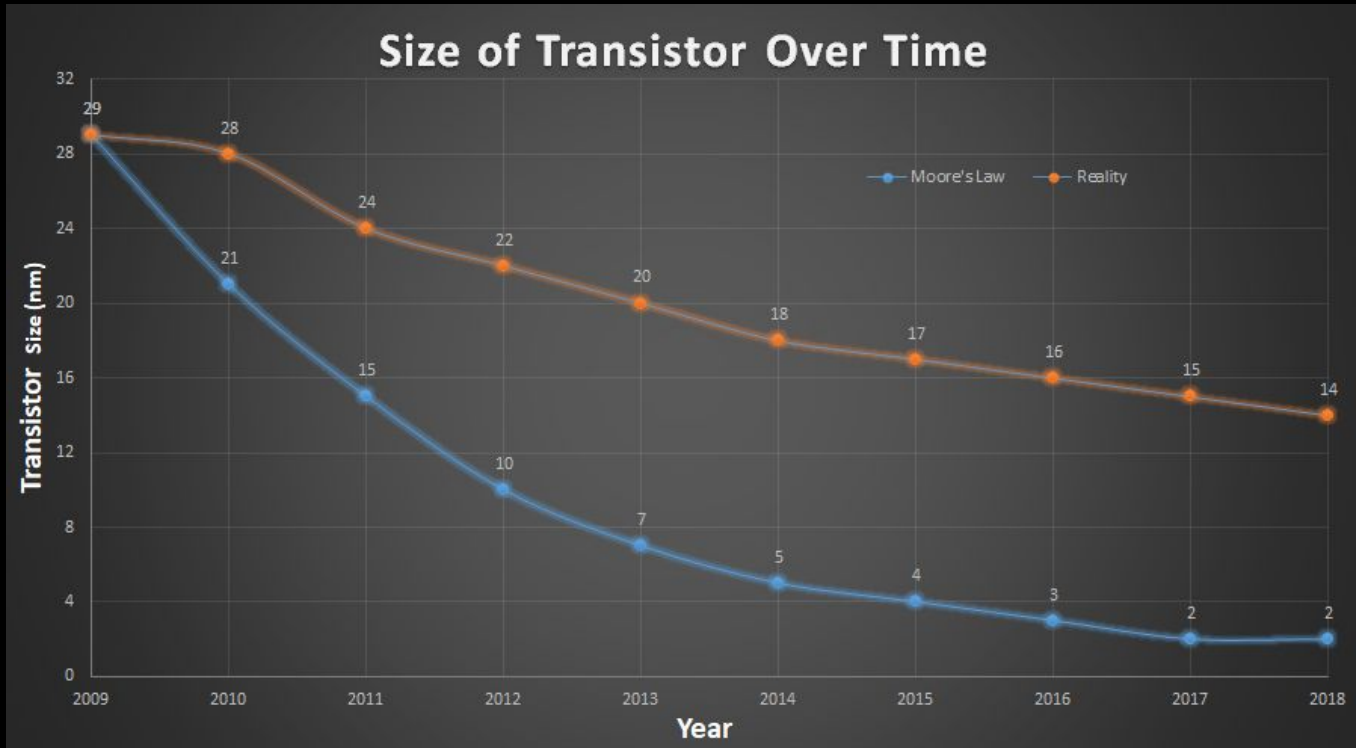


Figure 2. Moore's Law Graph

7x Slower

Moore's Law in the Future

- Smallest size today is 14 nm
- Two problems arise when we try to make them smaller
 - Heat
 - Quantum tunneling

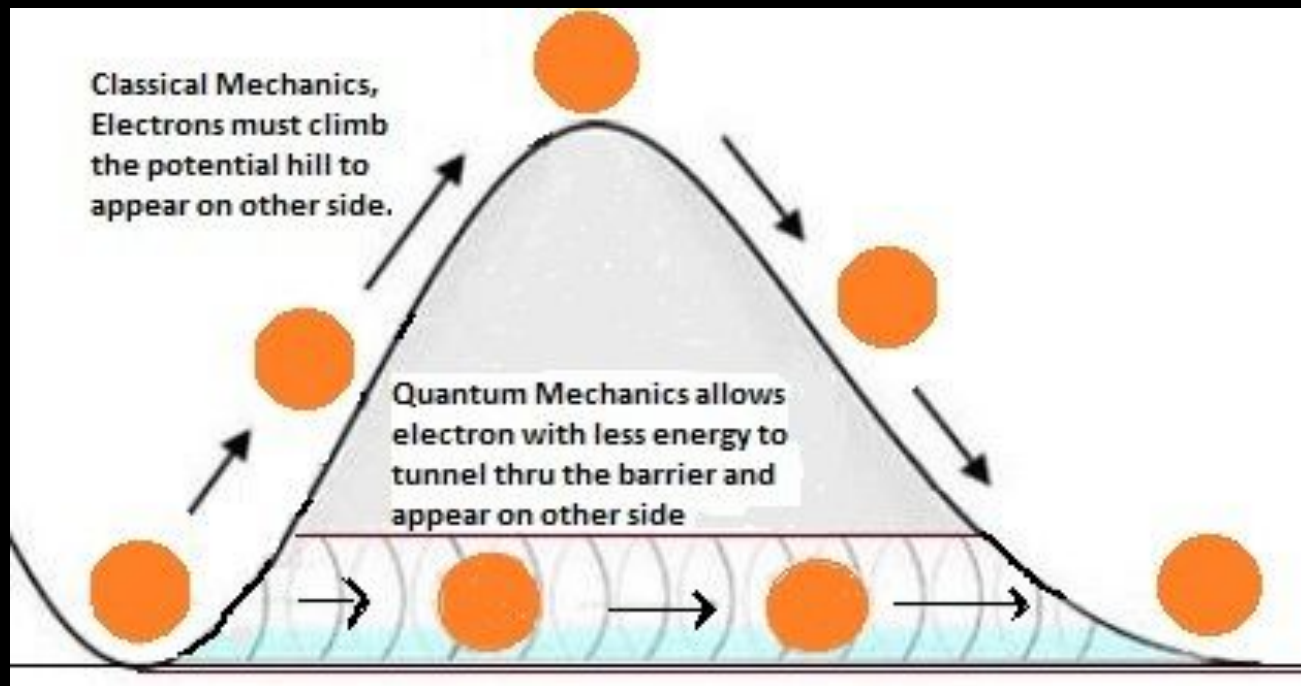


Figure 3. Quantum Tunneling

Spintronics

- Branch of Electronics
- Reads another property of an electron: its spin
- Values of 0 or 1 depend on spin

Spintronics

- Benefits:
 - Better performance
 - Lower power consumption
 - More resistant and reliable
 - Plausible with cheaper materials than silicon

Graphene

- Discovered in 2004
- Creators of Graphene won the Nobel Prize in 2010
- Incredibly conductive
- Lacks Band Gap

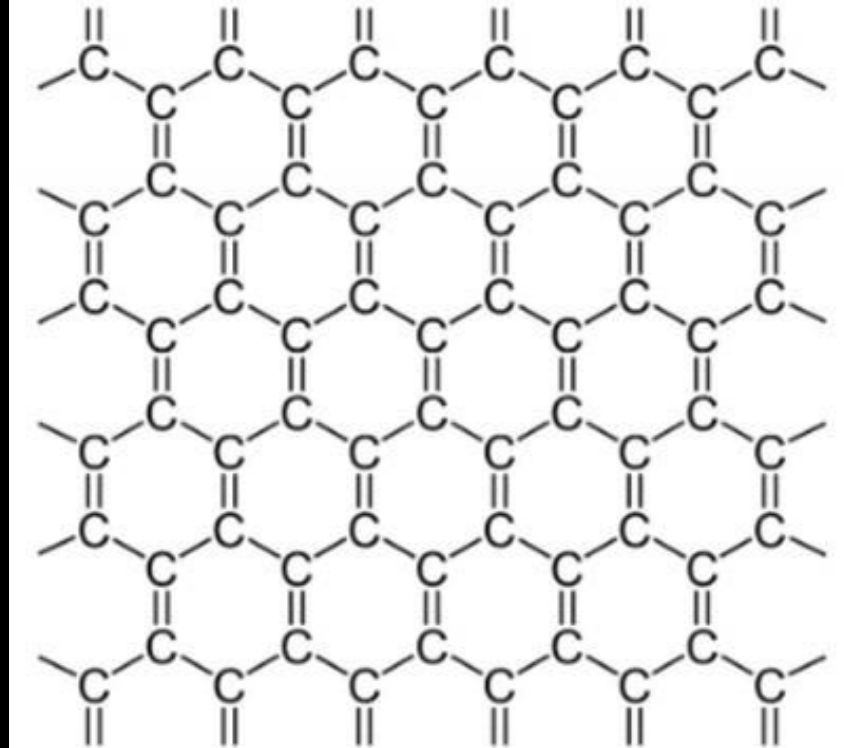


Figure 4. Graphene Structure

Spin Logic Transistors

- Three important variables to consider
 - Spin lifetime
 - Spin distance
 - Electron mobility

Purpose

- Increase efficiency of graphene spin logic
- Increase spin lifetime of transistor

Previous Work

- Multiple spintronic transistors already proposed
- Spintronic processors in works
- SSDs already commercially viable
- SSD has taken over data storage

Is there a correlation
between the spin
lifetime and spin
distance?

Hypotheses

Alternative- High correlation between spin lifetime and spin distance

Null- No correlation between spin lifetime and spin distance

Methods

- Systematic literature review
- Peer Reviewed Papers
- Databases:
 - EBSCOhost
 - Google Scholar
 - Nature
 - Graphene Flagship
- Data Analysis: R squared and Standard Error of Regression

Data Collected

- Information on the transistors that are being made currently including:
 - Spin Distance
 - Spin Lifetime



Results

	T (ps)	λ (μm)
Tombros et al.	170	2
Yang et al.	135	.7
Guimarães et al.	150	4.7
Birkner et al.	88	1.18
Józsa et al.	150	1.5
Dankert and Dash	40	1.2
Yan et al.	10	.020
Han et al.	50	2

Table 1. Data Collected Chart

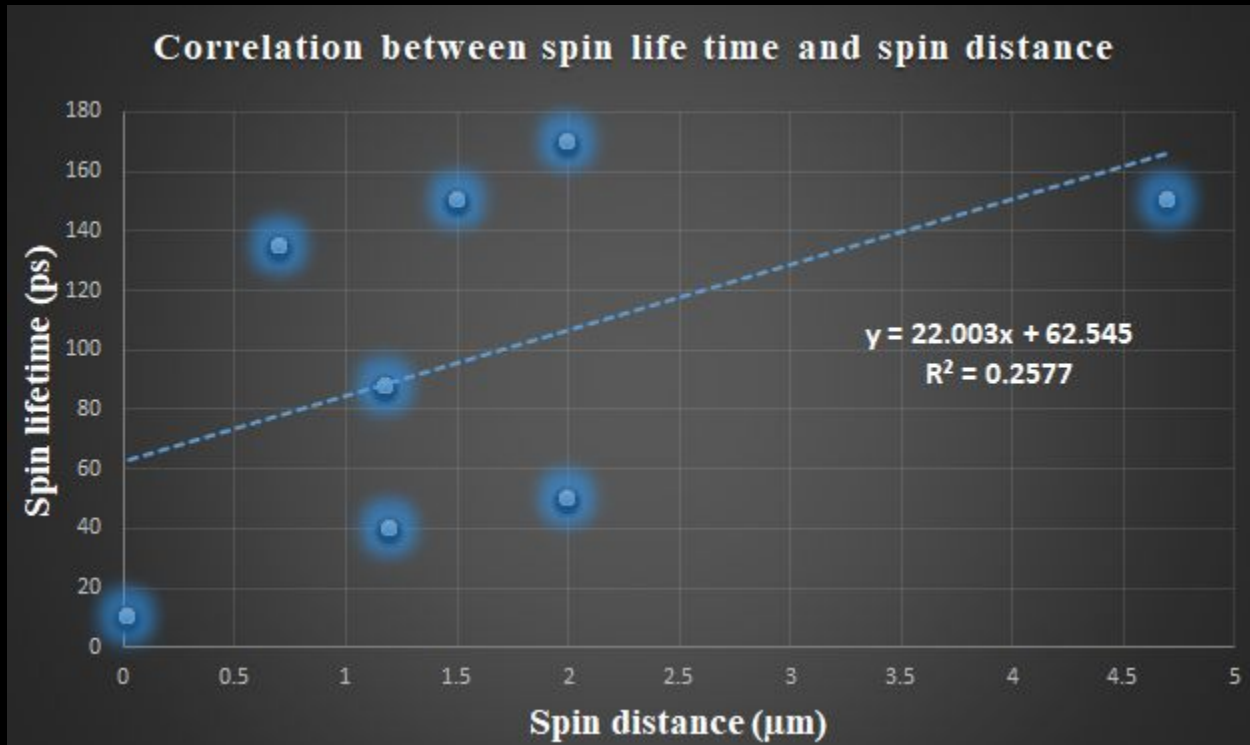


Figure 5. Linear Regression

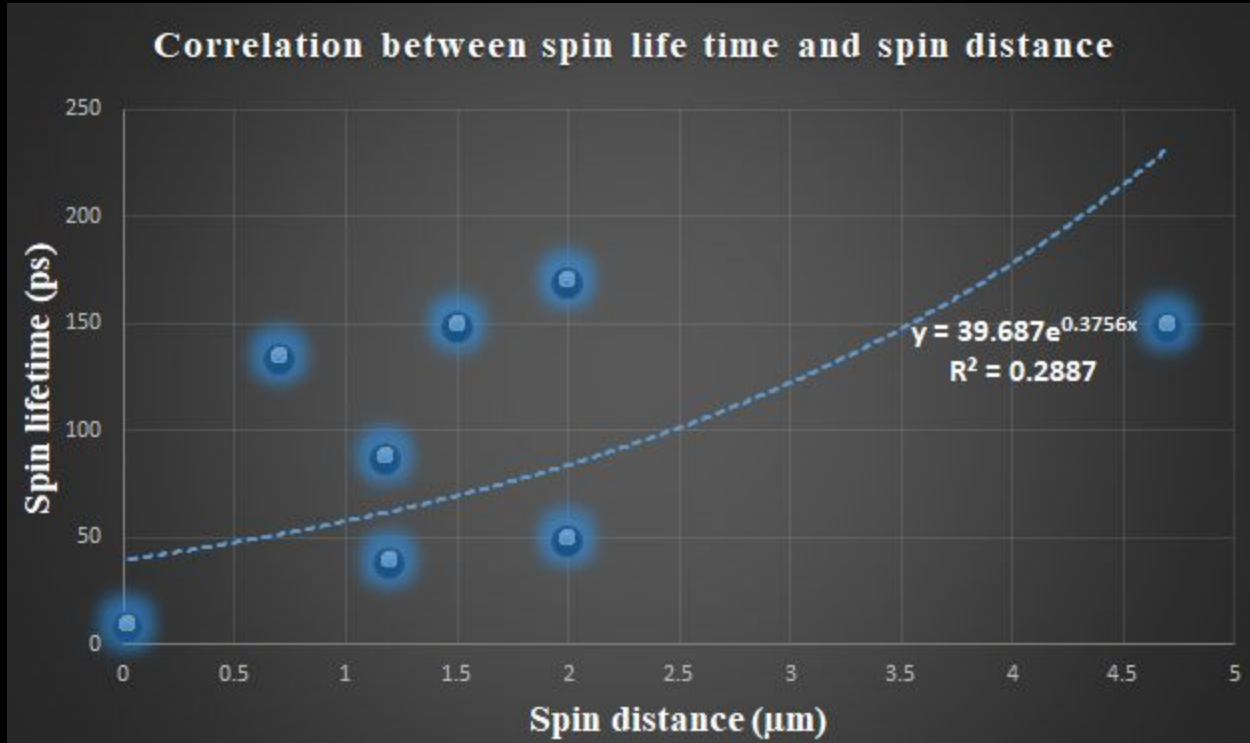


Figure 6. Exponential Regression

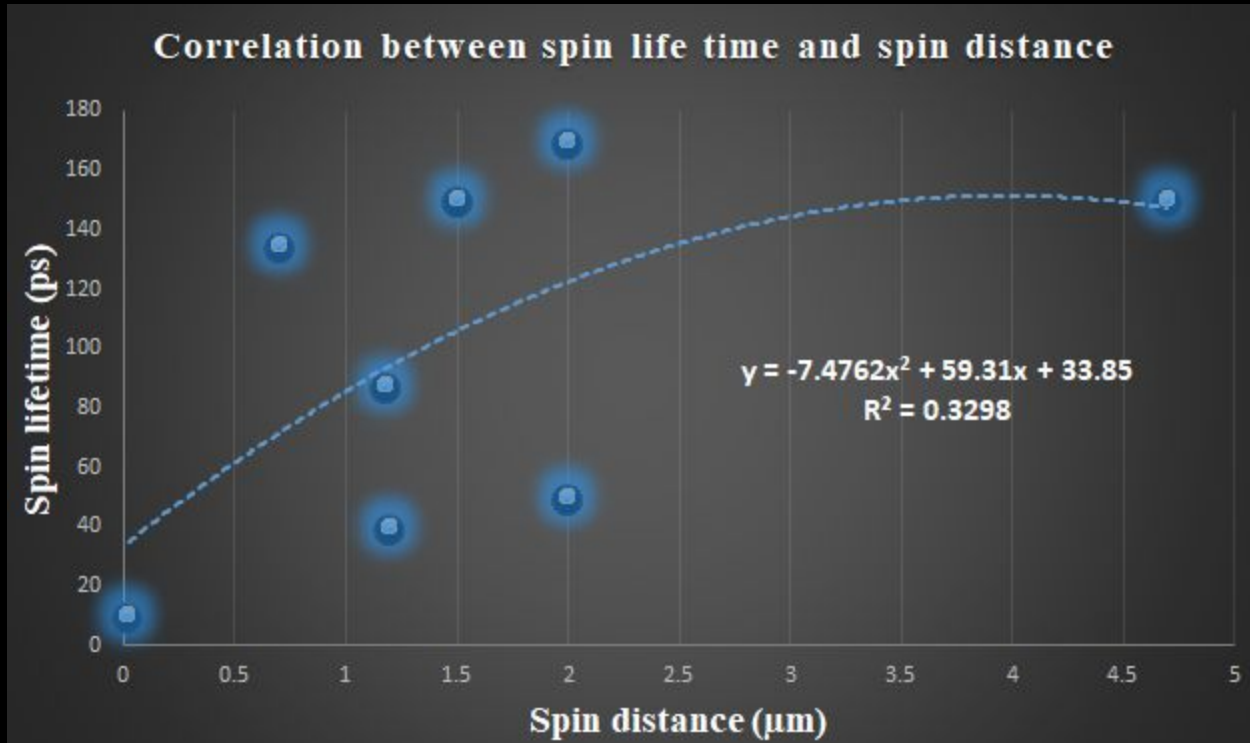


Figure 8. Polynomial Regression (2nd)

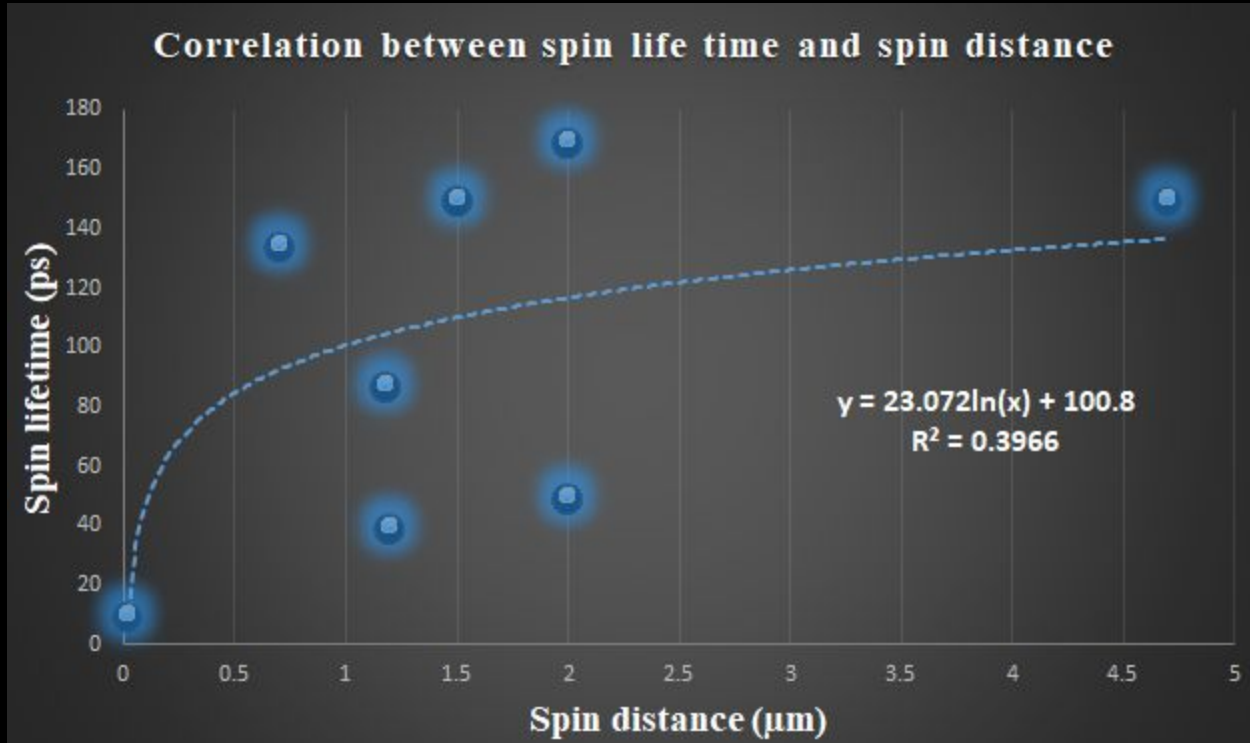


Figure 9. Logarithmic Regression

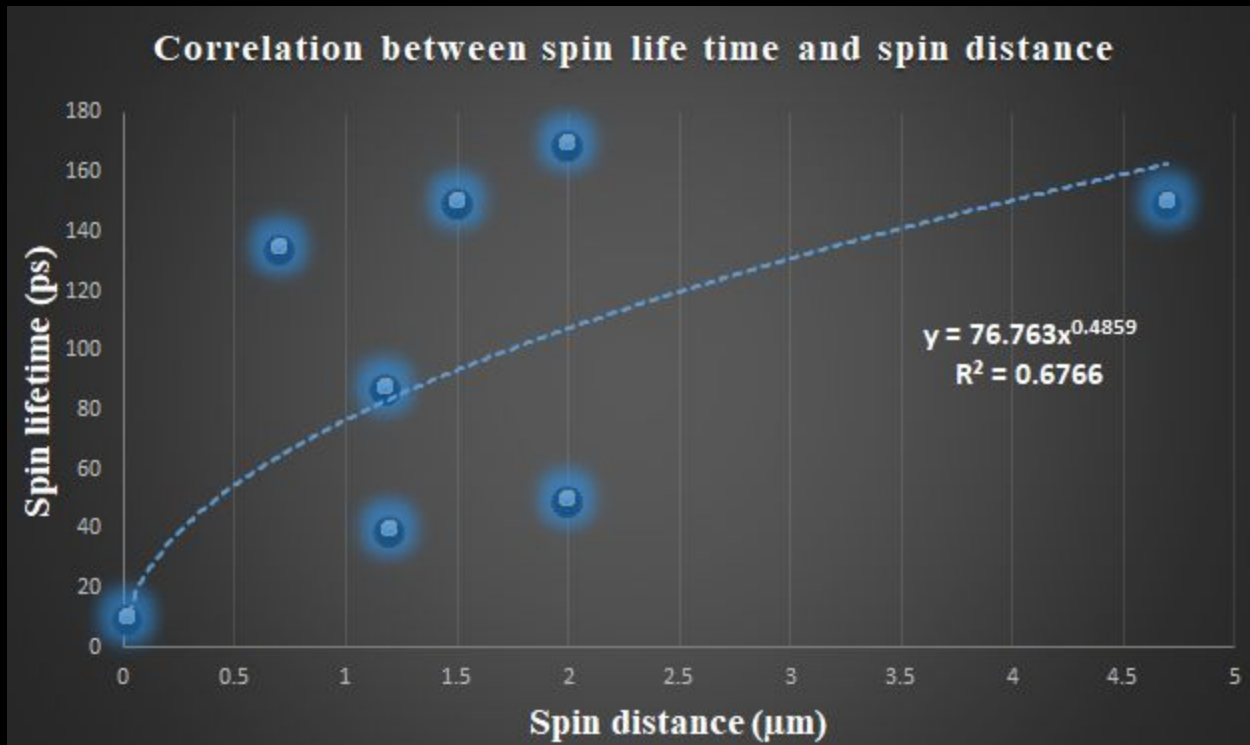


Figure 7. Power Regression

Regression	R ² value
Linear	.2577
Exponential	.2887
Polynomial (2nd)	.3298
Logarithmic	.3966
Power	.6766

Table 1. Data Collected Chart

$S=60.9841$



Conclusion

Discussion

- No observed correlation, accept null
- Highest R squared value observed .6766
- Standard error of regression > 2.5
- Unlikely for spin distance and spin lifetime to be related

Limitations

- Inaccurate measurements based on tools
- Impurities in Graphene
- Not enough trials to compare completely

Further Work


- Continue research to increase spin lifetime
- Compare different variables for correlation
 - Voltage gate
 - SOI of materials

Acknowledgements

- Dr.Dimitri
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References

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