

Making Posters

Plus some thoughts on the rules of scientific communication

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Department of Optics, UPOL

October 10, 2023

Introduction: Presentation of Your Research

Planning a Poster

Implementing a Poster: Typography and Technical Details

Conclusions

Please Interrupt!

Outline

Introduction: Presentation of Your Research

- A typical poster session

- Key points

Planning a Poster

Implementing a Poster: Typography and Technical Details

Conclusions

What we expect



What we get



What we get



What we get



What we get



What we get



Last two pics: Google "AGU (American Geophysical Union) Meeting"

What we get



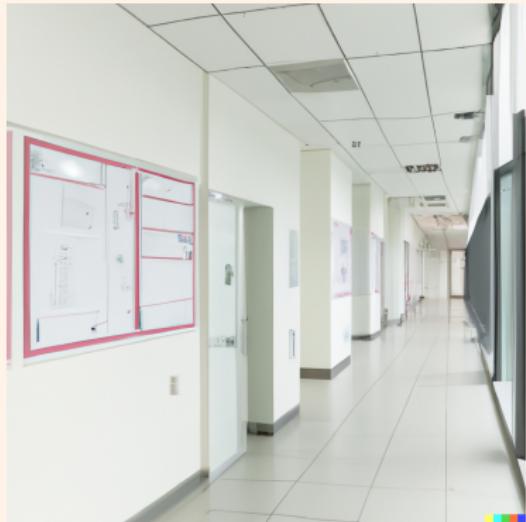
Posters for different purposes

Poster that hangs on a wall



Posters for different purposes

Poster that hangs on a wall



Poster that you hang out next to



Image source: Wikipedia "Poster Session"

DALL-E: 'research institute corridor with scientific posters on the walls'



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Our goal poster



Main Misconception About the Conference Posters

No ONE READS THEM

The Plan of the Presentation

Grab the attention

Try to not lose the attention

The Plan of the Presentation

Grab the attention

- Interesting title

- Large and nice figures

Try to not lose the attention

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- Keep things simple

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Prepare different level of details

- A few sentences summary

- “Elevator talk” — presentation in three minutes

- ...

- The full talk

The Plan of the Presentation

Grab the attention

- Interesting title

- Large and nice figures

Try to not lose the attention

- Keep things simple

Prepare different level of details

- A few sentences summary

- “Elevator talk” — presentation in three minutes

- ...

- The full talk

This is difficult

Seriously

Outline

Introduction: Presentation of Your Research

Planning a Poster

Sketching the structure

Contents of a poster

Implementing a Poster: Typography and Technical Details

Conclusions

Structure of Research/ The Problem



Problem

Structure of Research/ The Problem



Knowledge Before

Problem

Structure of Research/ The Problem



Problem

Knowledge Before

+

Tools

Structure of Research/ The Problem



Problem

Knowledge Before

+

Tools

=

Knowledge After

Practical Steps

Pick contents

Determine the main contribution

Write it down in 3 sentences + 1 figure

Prepare supporting data (definitions + graphs)

Sketch (pen + paper)

Make a few (2-4) sketches with different layout

Implement

Decide the tools (programs)

Choose the looks (fonts + colors)

Example Structure

Robust entanglement with a thermal mechanical oscillator

Andrej R. Rakhusovský and Radim Filip

rkhbsv@gmail.com

Palacký University
Olomouc

ABSTRACT

We consider a protocol to entangle an electromagnetic pulse with a mechanical oscillator at high temperature. We show this protocol to be capable of entangling currently existing thermal mechanical oscillators at relatively high temperatures. The protocol does not require any available cryostat or refrigeration of the mechanical part. We also predict a possibility of conditional superposition of the mechanical mode below the shot noise level at the cryostat temperature.

PROOF-OF-PRINCIPLE

- [1] Filip and V. Kuriš, *PRA* **87**, 052323 (2013)
 - Two modes (L and M) initially in gaussian states with variance $\sigma_L^2 = \sigma_M^2 = 1$ and $\langle L \rangle = \langle M \rangle = 0$
 - Two mode squeezing (AMF) interaction for finite time
 - Both modes are attenuated
- There is a threshold g_0 for entanglement
- Entanglement is robust against arbitrary attenuation
- This protocol can be used for entangling and squeezing (projecting the noisy mode to a squeezed state by a proper measurement) on light of the noisy mode

OUR APPROACH

We solve quantum Langevin equations for a pulsed system to estimate the covariance matrix

$$\dot{W}(t) = A(t)W(t), \quad W(0) = (N_L, P_L, X_M, P_M);$$

$$d\tilde{W}(t) = \tilde{M}(t)dW(t) - \int_0^t ds \tilde{M}(t-s)\tilde{f}(s); \quad \tilde{M}(t) = \exp(At);$$

$$V(t) = M(t)V(0)\tilde{M}^\dagger(t) + \int_0^t ds dt' \tilde{M}(t-s)\tilde{f}(s)\tilde{f}^\dagger(t-t').$$

Knowing the CM we are able to estimate log-negativity and the possibility of conditional squeezing

$$E_{\text{N}} = \max(\lambda_i) - \ln \sqrt{\lambda_i},$$

λ_i is the smaller symmetric eigenvalue of the CM.

OPTOMECHANICAL COUPLING

$$H_{\text{int}} = g_0(a_L^\dagger a_M + a_L a_M^\dagger) + g_1(a_L^\dagger a_M + a_L a_M^\dagger).$$

The dominant coupling is determined by the detuning $\Delta = \omega_m - \omega_L$, so in the resolved sideband regime ($|\Delta| > \kappa_L$)

- In blue detuning $\Delta < 0$ and $\Delta > 0$: Two mode squeezing between two modes, creates negative mechanical damping.
- In red detuning $\Delta \approx 0$: $\omega_m \gg \Delta$: Bistability, negative mechanical damping between the modes, creates positive damping.

PULSED CAVITY OPTOMECHANICS

Originally proposed in [Böker et al., *PRA* **84** (5), 052327] and demonstrated in electromechanics [Palencík et al., *Science* **342**, 710 (2013)].

This pulses enter the cavity separately. First, a blue detuned pulse entangles optical and mechanical mode; second, a red detuned pulse reads the state of the mechanical mode.

Utilization of pulses relieves the stability requirement. Input-output relations for entangling condition

$$A^{in} = \sqrt{-T}\tilde{A}^{in} - i\sqrt{T}\tilde{A}^{in\dagger}; \quad A^{in} = \int_0^{\infty} d\tau \tilde{a}_L^\dagger(1)e^{-i\omega_L \tau} d\tau;$$

$$A^{out} = \sqrt{T}\tilde{A}^{out} - i\sqrt{T}\tilde{A}^{out\dagger}; \quad A^{out} = \int_0^{\infty} d\tau \tilde{a}_L(1)e^{-i\omega_L \tau} d\tau.$$

Which corresponds to AMP interaction with gain $T = e^{2\pi\kappa_L/\omega_L}$ – optics and mechanics should be entangled regardless of the temperature of mechanical bath.

Similar input-output relations for red detuning correspond to BS-type interaction between optics and mechanics.

RESULTS

Entanglement between the pulses

Relative power to conditionally squeeze mechanical mode

Entanglement between intracavity and mechanical modes.

Entanglement versus normalized frequency of the pulses.

We used parameters of [Palencík et al., *Science* **342**, 710 (2013)] (marker lines) and [Chan et al., *Nature* **479**, 806 (2011)] (line fit lines).

What the people typically expect to see on a poster

Title: Problem that is solved
Presenting Author, Other Authors
Affiliations and Addresses

Logo/
Photo

Abstract

Materials

Results,
Conclusion
and Outlook

Introduction

Methods

References

Acknowledgments

Contact Information

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Introduction

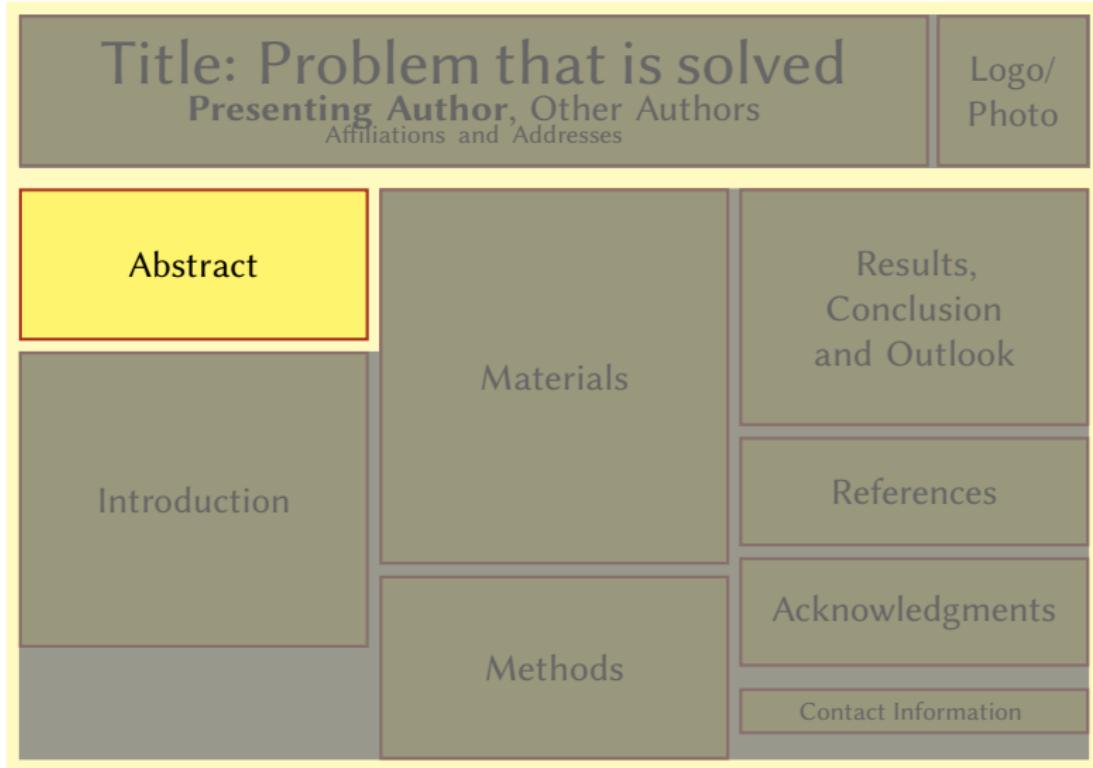
Methods

References

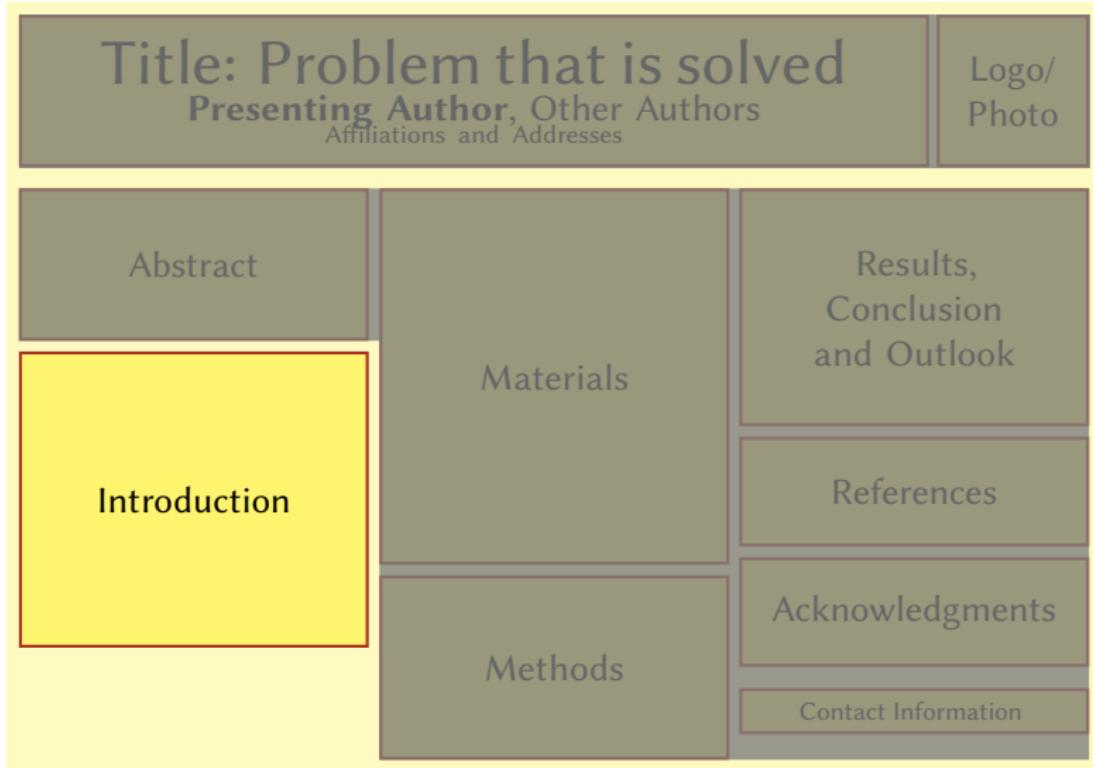
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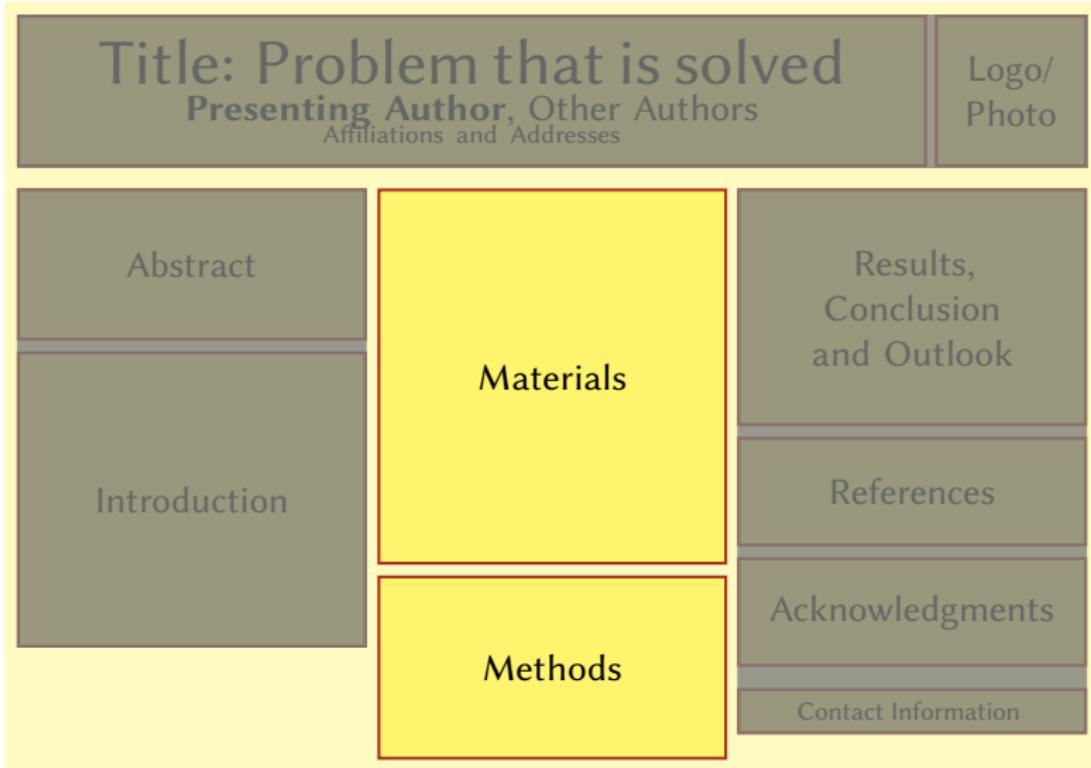
What the people typically expect to see on a poster



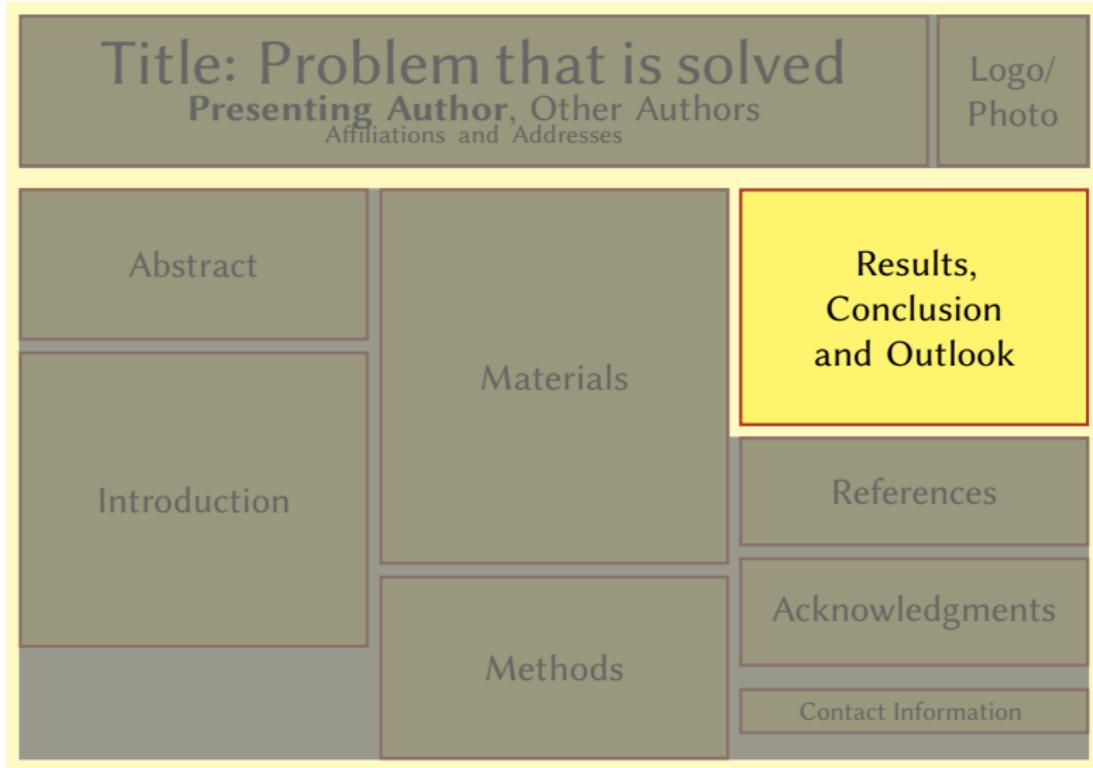
What the people typically expect to see on a poster



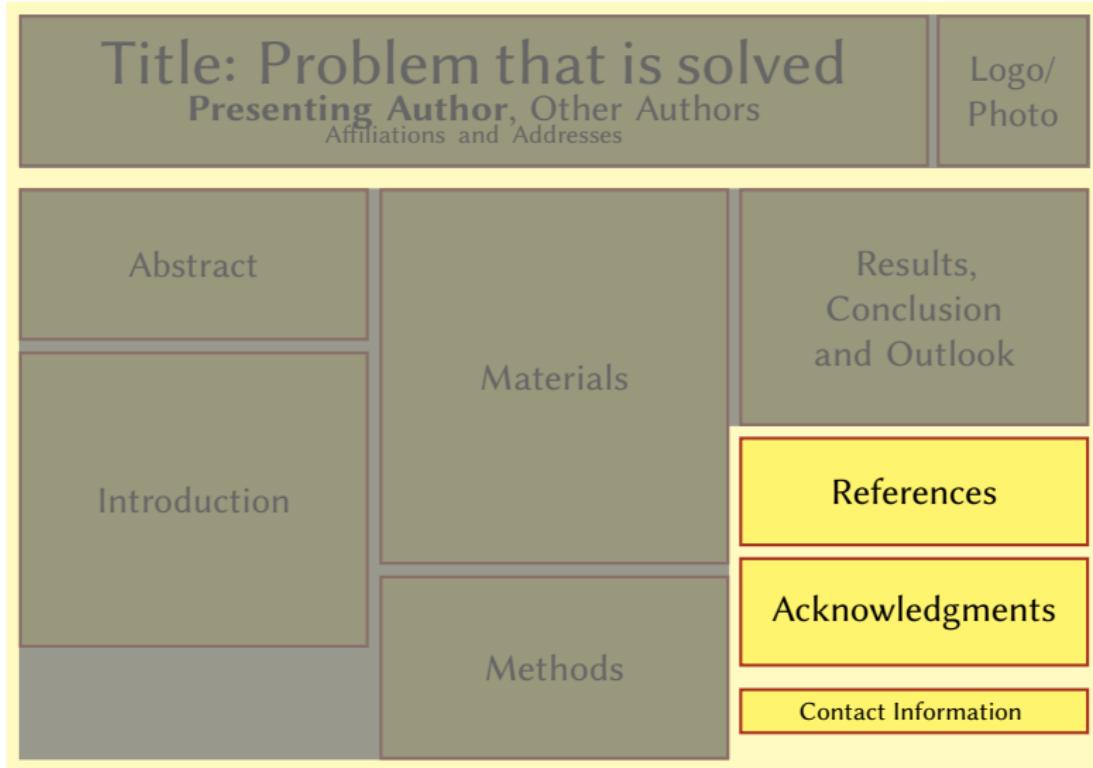
What the people typically expect to see on a poster



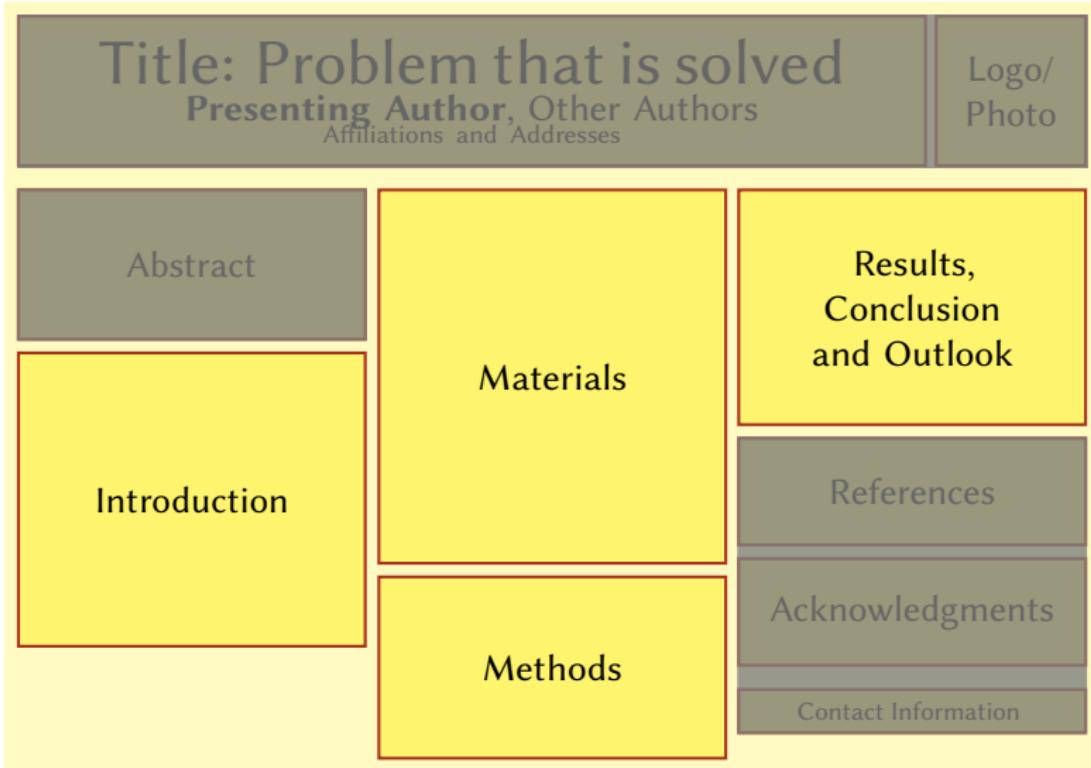
What the people typically expect to see on a poster



What the people typically expect to see on a poster



What the people typically expect to see on a poster



Which is which

Title

Extremely shortened contents

Abstract

Significantly shortened contents

Introduction

Motivation & Reviews & Definitions

Materials&Methods

The contents of your research

Conclusion

Slightly shortened contents

References

List of literature

Contact Information

Your email/ QR codes/ links to articles/ blogs etc.

Outline

Introduction: Presentation of Your Research

Planning a Poster

Implementing a Poster: Typography and Technical Details

Tools

Graphics

Fonts

Whitespace

Colors

Conclusions

Tools (Software)

Presentation making software

- PowerPoint
- OpenOffice/LibreOffice Impress
- Keynote
- Google Slides

Vector Editors

- Adobe Illustrator
- Corel Draw
- Inkscape
- OpenOffice/LibreOffice Draw

Publishing Software

- Microsoft Publisher, Adobe InDesign

LATEX

- Overleaf template library

Tools (Software)

Presentation making software

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LATEX

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Web search “Conference Poster Template”

Examples From the Internet



LOG IN HELP ▾ CONTACT US

PRINT MY POSTER

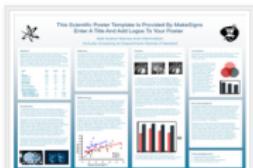
RESOURCES ▾

ACCESSORIES

SHIPPING

CART

Here are some PowerPoint templates to get you started. Feel free to change the colors and layout as needed. These templates are within the PowerPoint page size limit of 56" and comes in several different aspect ratios, each of which can be printed in a number of sizes (as listed).



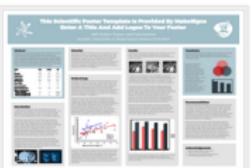
Persuading Sapphire

- 48 x 36 56x42 | 64x48
- 48 x 24 72x36 | 84x42 | 96x48
- 36 x 24 54x36 | 63x42 | 72x48
- 36 x 36 (square) 42x42 | 48x48
- 36 x 48 (vertical) 42x56 | 48x64



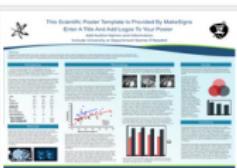
Pondering Peacock

- 48 x 36 56x42 | 64x48
- 48 x 24 72x36 | 84x42 | 96x48
- 36 x 24 54x36 | 63x42 | 72x48
- 36 x 36 (square) 42x42 | 48x48
- 36 x 48 (vertical) 42x56 | 48x64



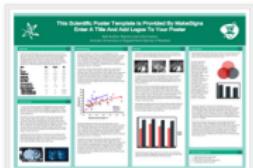
Assessing Slate

- 48 x 36 56x42 | 64x48
- 48 x 24 72x36 | 84x42 | 96x48
- 36 x 24 54x36 | 63x42 | 72x48
- 36 x 36 (square) 42x42 | 48x48
- 36 x 48 (vertical) 42x56 | 48x64



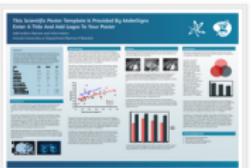
Hypothetical Ocean

- 48 x 36 56x42 | 64x48
- 48 x 24 72x36 | 84x42 | 96x48
- 36 x 24 54x36 | 63x42 | 72x48
- 36 x 36 (square) 42x42 | 48x48
- 36 x 48 (vertical) 42x56 | 48x64



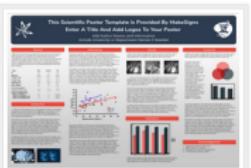
Philosophical Seafoam

- 48 x 36 56x42 | 64x48
- 48 x 24 72x36 | 84x42 | 96x48
- 36 x 24 54x36 | 63x42 | 72x48
- 36 x 36 (square) 42x42 | 48x48
- 36 x 48 (vertical) 42x56 | 48x64



Conceptualizing Cobalt

- 48 x 36 56x42 | 64x48
- 48 x 24 72x36 | 84x42 | 96x48
- 36 x 24 54x36 | 63x42 | 72x48
- 36 x 36 (square) 42x42 | 48x48
- 36 x 48 (vertical) 42x56 | 48x64



Perceptual Pewter

- 48 x 36 56x42 | 64x48
- 48 x 24 72x36 | 84x42 | 96x48
- 36 x 24 54x36 | 63x42 | 72x48
- 36 x 36 (square) 42x42 | 48x48
- 36 x 48 (vertical) 42x56 | 48x64



Deliberating Watermelon

- 48 x 36 56x42 | 64x48
- 48 x 24 72x36 | 84x42 | 96x48
- 36 x 24 54x36 | 63x42 | 72x48
- 36 x 36 (square) 42x42 | 48x48
- 36 x 48 (vertical) 42x56 | 48x64

Examples From the Internet

This Scientific Poster Template Is Provided By MakeSigns
Enter A Title And Add Logos To Your Poster

Add Author Names and Information
Include University or Department Names if Needed

Abstract
Add your information, graphs and images to this section.

Materials
Add your information, graphs and images to this section.

Results
Add your information, graphs and images to this section.

Conclusion
Add your information, graphs and images to this section.

Introduction
Add your information, graphs and images to this section.

Methodology
Add your information, graphs and images to this section.

Recommendations
Add your information, graphs and images to this section.

Acknowledgements
Add your information, graphs and images to this section.

Examples From the Internet



Poster template design: **Aragon**

Standard poster sizes in inches (Height x Width) - Click on a size to download

36x48 | 36x56 | 36x60 | 36x72 | 36x96 | 42x60 | 42x72 | 42x90 | 44x44 | 30x40 | 48x48 | 48x72 | 48x96 | Trifold | Virtual - Standard Screen (4:3 Ratio) | Virtual - Wide Screen (16:9 Ratio)

Standard poster sizes in centimeters (Height x Width) - Click on a size to download

122x91 | 100x70 | 140x100 | 100x100 | 200x100 | A0 | A1

- ▶ View Samples
- ▶ Learn how to customize the template colors



Poster template design: **Beaumont**

Standard poster sizes in inches (Height x Width) - Click on a size to download

36x48 | 36x56 | 36x60 | 36x72 | 36x96 | 42x60 | 42x72 | 42x90 | 44x44 | 30x40 | 48x48 | 48x72 | 48x96 | Trifold | Virtual - Standard Screen (4:3 Ratio) | Virtual - Wide Screen (16:9 Ratio)

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122x91 | 100x70 | 140x100 | 100x100 | 200x100 | A0 | A1

- ▶ View Samples
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Poster template design: **Newfield**

Standard poster sizes in inches (Height x Width) - Click on a size to download

36x48 | 36x56 | 36x60 | 36x72 | 36x96 | 42x60 | 42x72 | 42x90 | 44x44 | 30x40 | 48x48 | 48x72 | 48x96 | Trifold | Virtual - Standard Screen (4:3 Ratio) | Virtual - Wide Screen (16:9 Ratio)

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122x91 | 100x70 | 140x100 | 100x100 | 200x100 | A0 | A1

- ▶ View Samples
- ▶ Learn how to customize the template colors

#betterposter on Twitter

Title:
Subtitle



BACKGROUND: Who cares? Explain why your study matters in the fastest, most brutal way possible (feel free to add graphics!).

METHODS

1. Collected [what] from [population]
2. Tested it with X process.
3. Illustrate your methods if you can.
4. Try a flowchart!

RESULTS

- Graph/table with **essential results only**.
- All the other correlations in the ammo bar.

Main finding goes here, translated into plain English. Emphasize the important words.



Visualize your findings with an image, graphic, or a key figure.



Take a picture to download the full paper

AMMO BAR

Delete this and replace it with your...

- Extra Graphs
- Extra Correlation tables
- Extra Figures
- Extra nuance that you're worried about leaving out.
- **Keep it messy!** This section is just for you.

✉ Leeroy Jenkins, author2, author3, author4, author5, author6, author7, author42



#betterposter on Twitter

How Are You Feeling Today, Dave? Using IBM's Watson Supercomputer to Extract Emotions from Natural Language

Mike A. Morrison

INTRO

- IBM Watson is a supercomputer able to process naturally written language. It can reportedly read a body of text, and extract meaning from it, even if the author was feeling when they wrote it.
- This study compared Watson's ratings of emotional tone in text to self-report ratings, using a sample of crew members participating in NASA analog science mission in Antarctica.

METHODS

- Participants: N= 6 crew members participating in a NASA Science Mission in Antarctica. T = 42 (average) mission days per crew member.
- Diaries: Crew members wrote freeform in daily diaries each day. Diaries typically discuss activities from the day, and other crew members.
- Self-Reports: Crew members completed self-report measures of psychological distress, happiness, conflict management, and physical activity.
- Using Watson's Alchemy Language service, Watson analyzed diary text and reported estimates of Fear, Joy, Sadness, Anger, and Disgust in each diary entry.
- Analyses tested for significant correlations between Watson's measures of Fear, Joy, Sadness, Anger, and Disgust against a battery of self-report measures of daily attitudes.

RESULTS

- Watson's estimates of happiness and sadness correlated significantly with related self-report measures, but Watson's estimates of disgust, fear, and anger showed no significant correlations.



IBM Watson can accurately detect joy and sadness in samples of written language.

	Watson Happiness	Watson Sadness
Self-report Happiness	.21**	-.22**
Self-report Distress	n/a	.15*
Self-report Conflict Management	n/a	-.24*
Self-report Physical Activity	.18**	-.25**

- Participants:
- N = 6 crew members participating in a Science Mission in Antarctica
 - T = 42 (average) mission days per crew member

How do Natural Language Processors Like IBM Watson Work?

- 1 A software algorithm reads in a body of text (in this case, a diary entry).
- 2 The text is converted into features (e.g., frequency of specific words, punctuation usage, sentence length).
- 3 An algorithm identifies which features in the text are associated with scores on a 'higher' criteria (e.g., self-report measures of happiness, sadness, etc.).
- 4 Machine learning algorithms create a set of combined language features that reliably predict scores on the criteria of interest in the text data.
- 5 The trained algorithm looks for these special features in new bodies of text, and outputs an estimate of the criteria.



#betterposter on Twitter

We present a method to accurately and robustly extract inclination angles from red giant stars.



Bayesian hierarchical inference of asteroseismic inclination angles

James S. Kuszlewicz^{1,2}, William J. Chaplin^{1,3}, Thomas S.H. North^{1,3}, Will M. Farr^{1,3,4}, Keaton J. Bell^{1,2}, Guy R. Davies^{1,3}, Tiago L. Campante^{1,3}, Saska Hekker^{1,2}.

Background

The stellar inclination angle is a valuable parameter in many different areas, from characterisation of the geometry of exoplanet and eclipsing binary systems, to stellar populations.

Objective

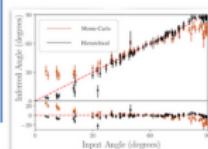
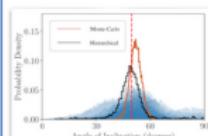
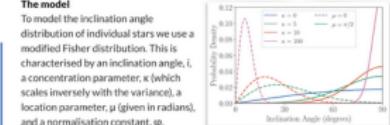
To accurately and robustly extract inclination angles from red giants.

Methods

1. Select all long-cadence Kepler red giants from Stello et al. (2013) where $233\mu\text{Hz} < \nu_{\text{max}} < 270\mu\text{Hz}$.
2. Identify and fit $\ell = 1$ mixed modes for each star, storing the inclination angle posterior probability density function (PDF) for each mixed mode.
3. Infer inclination angles for each star using a bayesian hierarchical scheme (Hogg et al. 2010) using the individual mode estimates.
4. Test on artificial data to ensure consistency of method.

The model

To model the inclination angle distribution of individual stars we use a modified Fisher distribution. This is characterised by an inclination angle, i , a concentration parameter, κ (which scales inversely with the variance), a location parameter, μ (given in radians), and a normalisation constant, φ .



Individual angles and testing with artificial data

An example applied to a single artificial star is shown on the left. The input angle (red dashed line) is close to 50 degrees and the individual PDFs for each mixed mode are plotted in blue. The weighted mean Monte-Carlo estimate is shown in orange and the posterior PDF of the location parameter from the hierarchical analysis is shown in black.

To the left is the inferred inclination angle against the input angle for an artificial sample of stars. The hierarchical method (black) is able to recover the input angle in almost all cases, unlike the Monte-Carlo method (orange) which becomes heavily biased at low and high angles. This can also be seen in the residuals about the 1:1 line (red dashed line) in the bottom panel.

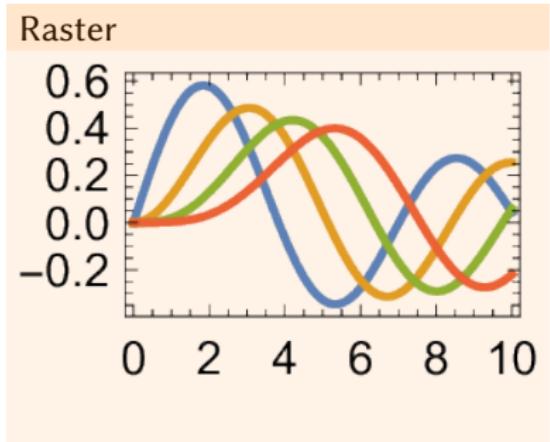
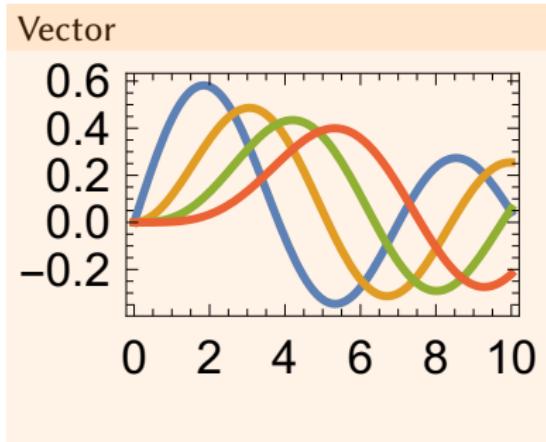
Max-Planck-Institut für Sonnensystemforschung, Göttingen, Germany
1 Department of Physics, University of Exeter, Exeter, UK
2 School of Physics and Astronomy, University of Birmingham, Birmingham, UK
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Hogg D.W., Chaplin W.J., North T.S.H., et al. 2010, ApJ, 721, 2794
Hogg D.W., Chaplin W.J., North T.S.H., et al. 2013, MNRAS, 431, 1453
Hogg D.W., et al. 2013, Nat. 493, 140

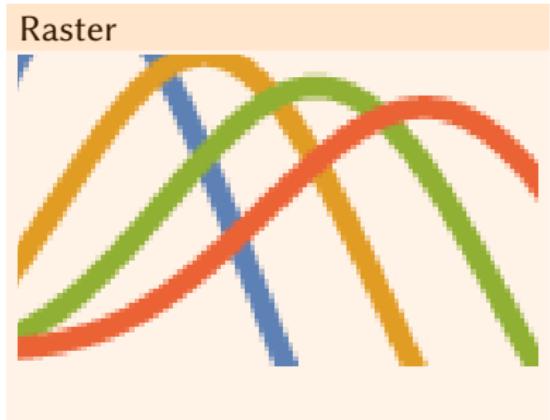
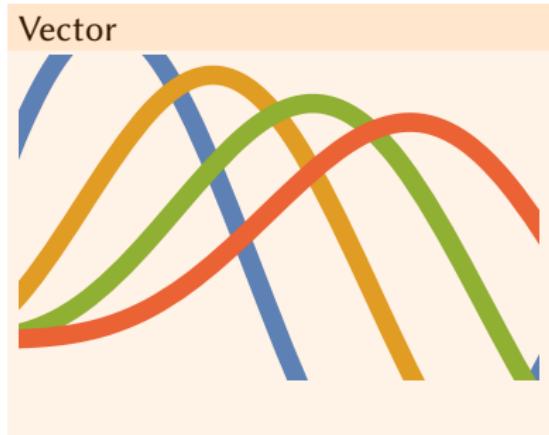


Use Vector Graphics



Vector Editors: Adobe Illustrator, Corel Draw, Inkscape, OpenOffice Draw
I use \LaTeX which is a markup language

Use Vector Graphics



Vector Editors: Adobe Illustrator, Corel Draw, Inkscape, OpenOffice Draw
I use \LaTeX which is a markup language

Use Vector Graphics



Vector Editors: Adobe Illustrator, Corel Draw, Inkscape, OpenOffice Draw
I use \LaTeX which is a markup language

Example Structure

POSTER DESIGN BY: J. M. S.

Entanglement with a thermal mechanical oscillator

Andrey A. Rakhubaovskiy and Radim Filip

Abstract

We propose a protocol to entangle two modes at high temperature. We show that the protocol is capable of entangling currently existing thermal mechanical oscillators at high (above available crystal) temperatures of the mechanical part. We also predict a possibility of conditional separating of the mechanical mode below the shot noise level at the cryostat temperature.

A. INTRODUCTION

Quantum optics and quantum computing have been the most active fields of research in the last decade. One of the main goals of quantum optics is to entangle different modes. This can be done by using various methods such as Raman scattering, parametric down-conversion, or cavity optomechanics. In this poster we propose a protocol to entangle two modes at high temperature. We show that the protocol is capable of entangling currently existing thermal mechanical oscillators at high (above available crystal) temperatures of the mechanical part. We also predict a possibility of conditional separating of the mechanical mode below the shot noise level at the cryostat temperature.

B. PROPOSED SCHEME

The proposed scheme is shown in Fig. 1. It consists of two parts: a cavity and a thermal mechanical oscillator. The cavity is formed by two mirrors and contains two modes. The thermal mechanical oscillator is a mechanical resonator coupled to one of the cavity modes. The protocol starts with a sequence of pulses that creates an entangled state between the two modes. Then, the system is cooled down to the shot noise level. Finally, a sequence of pulses is applied to the thermal mechanical oscillator to conditionally separate the mechanical mode from the cavity mode.

C. RESULTS

Figure 2 shows the results of numerical simulations. The figure shows the entanglement between the two modes as a function of time. The entanglement is measured using the von Neumann entropy. The results show that the entanglement reaches a maximum value of approximately 0.5 at around 100 ms. After this point, the entanglement decreases rapidly, reaching a minimum value of approximately 0.1 at around 200 ms. This is followed by a period of oscillation between 0.1 and 0.2 until the system reaches the shot noise level at around 300 ms.

D. CONCLUSION

In conclusion, we have proposed a protocol to entangle two modes at high temperature. We have shown that the protocol is capable of entangling currently existing thermal mechanical oscillators at high (above available crystal) temperatures of the mechanical part. We have also predicted a possibility of conditional separating of the mechanical mode below the shot noise level at the cryostat temperature.

ACKNOWLEDGMENTS

This work was supported by the Ministry of Education, Youth and Sports of the Czech Republic under grant No. 17-07896Y. The authors would like to thank the anonymous reviewers for their valuable comments and suggestions.

REFERENCES

- [1] H. Kimble, "The quantum Internet," *Nature*, vol. 470, pp. 337–342, 2011.
- [2] J. D. Thompson, "Cavity optomechanics: Entanglement and control of mechanical motion," *Rev. Mod. Phys.*, vol. 82, pp. 1909–1951, 2010.
- [3] J. M. S., "Entanglement with a thermal mechanical oscillator," *arXiv preprint arXiv:1805.02020*, 2018.

POSTER DESIGN BY: J. M. S.

Entanglement with a thermal mechanical oscillator

Andrey A. Rakhubaovskiy and Radim Filip

Abstract

We propose a protocol to entangle two modes at high temperature. We show that the protocol is capable of entangling currently existing thermal mechanical oscillators at high (above available crystal) temperatures of the mechanical part. We also predict a possibility of conditional separating of the mechanical mode below the shot noise level at the cryostat temperature.

A. INTRODUCTION

Quantum optics and quantum computing have been the most active fields of research in the last decade. One of the main goals of quantum optics is to entangle different modes. This can be done by using various methods such as Raman scattering, parametric down-conversion, or cavity optomechanics. In this poster we propose a protocol to entangle two modes at high temperature. We show that the protocol is capable of entangling currently existing thermal mechanical oscillators at high (above available crystal) temperatures of the mechanical part. We also predict a possibility of conditional separating of the mechanical mode below the shot noise level at the cryostat temperature.

B. PROPOSED SCHEME

The proposed scheme is shown in Fig. 1. It consists of two parts: a cavity and a thermal mechanical oscillator. The cavity is formed by two mirrors and contains two modes. The thermal mechanical oscillator is a mechanical resonator coupled to one of the cavity modes. The protocol starts with a sequence of pulses that creates an entangled state between the two modes. Then, the system is cooled down to the shot noise level. Finally, a sequence of pulses is applied to the thermal mechanical oscillator to conditionally separate the mechanical mode from the cavity mode.

C. RESULTS

Figure 2 shows the results of numerical simulations. The figure shows the entanglement between the two modes as a function of time. The entanglement is measured using the von Neumann entropy. The results show that the entanglement reaches a maximum value of approximately 0.5 at around 100 ms. After this point, the entanglement decreases rapidly, reaching a minimum value of approximately 0.1 at around 200 ms. This is followed by a period of oscillation between 0.1 and 0.2 until the system reaches the shot noise level at around 300 ms.

D. CONCLUSION

In conclusion, we have proposed a protocol to entangle two modes at high temperature. We have shown that the protocol is capable of entangling currently existing thermal mechanical oscillators at high (above available crystal) temperatures of the mechanical part. We have also predicted a possibility of conditional separating of the mechanical mode below the shot noise level at the cryostat temperature.

ACKNOWLEDGMENTS

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Robust entanglement with a thermal mechanical oscillator

Andrey A. Rakhubaovskiy and Radim Filip

Abstract

We consider a protocol to entangle an electromagnetic pulse with a mechanical oscillator at high temperature. We show this protocol to be capable of entangling currently existing thermal mechanical oscillators at high (above available crystal) temperatures of the mechanical part. We also predict a possibility of conditional separating of the mechanical mode below the shot noise level at the cryostat temperature.

OPTOMECHANICAL COUPLING

The dominant coupling is determined by the detuning $\Delta = \omega_{\text{cav}} - \omega_{\text{mech}}$, so in the resolved sideband regime ($|\Delta| < \kappa$):

- In blue detuning ($\omega_{\text{cav}} < \omega_{\text{mech}} + \Delta$) Two modes cross over, creating two modes, creating negative mechanical damping.
- In red detuning ($\omega_{\text{cav}} > \omega_{\text{mech}} + \Delta$) Two modes cross over, creating two modes, creating positive damping.

PULSED CAVITY OPTOMECHANICS

Originally proposed in Blinov et al. *PRA* 84 (5), 052327 (2011) and demonstrated by Franssen et al. *Phys. Rev. Lett.* 104, 71301 (2010).

Two pulses enter the cavity separately. First, a blue detuned pulse entangles optical and mechanical mode; second, a red detuned pulse separates the modes.

OUR APPROACH

We solve quantum Langevin equations for a pulsed system to estimate the covariance matrix:

$$\dot{\hat{A}}(t) = \hat{A}(t) \left(\frac{d}{dt}V(t) - \frac{d}{dt}W(t) \right) = (\hat{X}_1, \hat{P}_1, \hat{X}_M, \hat{P}_M);$$

$$\dot{V}(t) = \hat{M}(t)\hat{W}(t) + \int_0^t d\tau M(\tau) - \kappa V(t); \quad \hat{W}(t) = \exp(\hat{A}(t));$$

$$V(t) = \hat{M}(t)V(0)\hat{M}^\dagger(t) + \int_0^t d\tau \hat{M}^\dagger(t)\hat{W}(t) - \kappa V(t)^2.$$

Knowing the values of V and W we are able to estimate log. negativity and the possibility of conditional separating

$$T_{\text{sep}} = \max\{0, -\ln \lambda_{\text{min}}\},$$

λ_{min} is the smaller synoptic eigenvalue of the CM.

RESULTS

A. Entanglement between the pulses

The figure shows the entanglement between the two modes as a function of time. The entanglement is measured using the von Neumann entropy. The results show that the entanglement reaches a maximum value of approximately 0.5 at around 100 ms. After this point, the entanglement decreases rapidly, reaching a minimum value of approximately 0.1 at around 200 ms. This is followed by a period of oscillation between 0.1 and 0.2 until the system reaches the shot noise level at around 300 ms.

B. Entanglement between intracavity and mechanical modes

The figure shows the entanglement between the two modes as a function of time. The entanglement is measured using the von Neumann entropy. The results show that the entanglement reaches a maximum value of approximately 0.5 at around 100 ms. After this point, the entanglement decreases rapidly, reaching a minimum value of approximately 0.1 at around 200 ms. This is followed by a period of oscillation between 0.1 and 0.2 until the system reaches the shot noise level at around 300 ms.

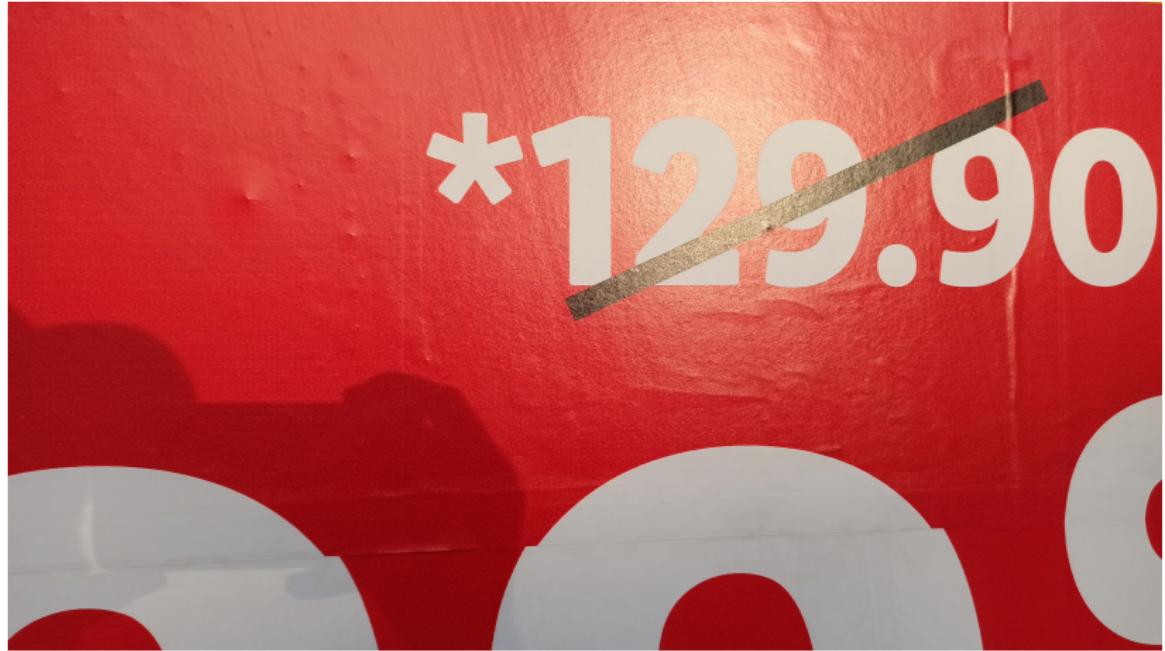
C. Entanglement versus delay between the pulses

We used parameters of Franssen et al. *Science* 342, 710 (2013) (Blinov laser) and Chan et al. *Nature* 467, 606 (Jaguar laser).

Importance of Vector graphics



Importance of Vector graphics



Importance of Vector graphics



Which Fonts to Use

Sans-Serif

It doesn't matter how beautiful your theory is, it doesn't matter how smart you are. If it doesn't agree with experiment, it's wrong.

Richard Feynman

Serif

It doesn't matter how beautiful your theory is, it doesn't matter how smart you are. If it doesn't agree with experiment, it's wrong.

Richard Feynman

Sans-Serif fonts: Helvetica, Arial, Bitstream Vera, DejaVu, whatever
I use Linux Biolinum / Linux Libertine
Avoid Microsoft ComicSans

Font Size

USE LARGE FONT!

Text	24 pt
Headings	48 pt
Titles	72 pt

The Appropriate Title



Adjust line separation

Fall in love with some activity, and do it! Nobody ever figures out what life is all about, and it doesn't matter. Explore the world. Nearly everything is really interesting if you go into it deeply enough. Work as hard and as much as you want to on the things you like to do the best. Don't think about what you want to be, but what you want to do. Keep up some kind of a minimum with other things so that society doesn't stop you from doing anything at all.

R. Feynman

Fall in love with some activity, and do it! Nobody ever figures out what life is all about, and it doesn't matter. Explore the world. Nearly everything is really interesting if you go into it deeply enough. Work as hard and as much as you want to on the things you like to do the best. Don't think about what you want to be, but what you want to do. Keep up some kind of a minimum with other things so that society doesn't stop you from doing anything at all.

Divide text into paragraphs

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Use Appropriate Colors

Use high contrast colors, like black on a light color.

Avoid green on other ligths.

Try to use emphasis moderately, as multiple emphasized words only cause loss of attention, complicate the comprehension and look awful.

Do not fill background.

Use high contrast colors, like black on a light color.

Avoid green on other ligths.

Try to use emphasis moderately, as multiple emphasized words only cause loss of attention, complicate the comprehension and look awful.

Do not fill background.

Zeroth rule of typography

You can break any rule as long
as you are aware of it

Outline

Introduction: Presentation of Your Research

Planning a Poster

Implementing a Poster: Typography and Technical Details

Conclusions

Conclusions

The poster is your way
to convey your message

Message

- Be able to grab the attention
- Provide necessary introduction
- Supplement the needed details

Text and Graphics

- Work on graphical parts
- Make the poster readable

Conclusions

The poster is your way
to convey your message
with help of text and graphics

Message

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- Provide necessary introduction
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Text and Graphics

- Work on graphical parts
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Conclusions

The poster is your way
to convey your message
with help of text and graphics

to the people who came to grab a beer

Message

- Be able to grab the attention
- Provide necessary introduction
- Supplement the needed details

Text and Graphics

- Work on graphical parts
- Make the poster readable

Last Minute Checklist

Images do not pixelate on zooming in

Text is readable (font sizes are appropriate)

Spelling is correct