

Title of the experiment

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Abstract

This workbook is a template for a written report on exercises performed by students of physics within Physics Laboratory II (IIPF) at the Institute of Physics at the Jagiellonian University. It contains detailed instructions for the layout of the text and the content of each section. The template was created using L^AT_EX which is the standard package used in preparing papers in most scientific journals. The report should show evidence of student's mastery of the entire experiment, and possess a neat appearance with concise and correct English. Its length can not exceed **6 pages**. Essential for every article is *Abstract* as it is read by the largest number of people. It should briefly (**up to 200 words**) describe the purpose, method and most important quantitative results, together with their uncertainties and possibly a brief conclusion.

1. Introduction

An important element in the education of physicist is the ability to use standard tools such as L^AT_EX and Word, which allow you to share your work with others in a generally accepted and professional manner. Spending some time studying and modifying this document will improve your ability to use L^AT_EX/Word to efficiently create the technical documents you need. For detailed instructions on compiling L^AT_EX documents, for different operating systems, see *Appendix A*.

Each report begins with *Introduction*. The introduction should include – to the extent agreed with the tutor – the most important information about the theory and the experimental method as well as the definitions and equations necessary for carrying out the experiment and processing experimental data. Every effort should be made to make this part of the report concise and at the same time understandable for the colleague, the student of the Physics Laboratory II, who does not have detailed knowledge about this particular experiment. It is best to send the reader to appropriate books, articles or websites, which references should be included in the *Literature* section. It is absolutely forbidden to copy the introduction of the experiment manual or pages from Wikipedia, encyclopaedia or other textbooks and scientific books. You should refer the reader to the literature that are the source of information you provide in the sentence or paragraph.

One of the biggest advantages of L^AT_EX package (to a lesser extent Word) is the ability to make all sorts of mathematical equations. In reports, the most common types of equations are single-line equations such as equation (1)

$$\chi_+(x) = x^2 + \frac{\partial y}{\partial x} \times \sqrt{\langle \psi | \alpha^\dagger | \phi \rangle} - \cos \theta. \quad (1)$$

Sometimes, however, it is necessary to introduce equa-

tions that occupy more than one line of the two-column page. A good solution in this case is to divide the equation into several lines and assign them one number as in the equation (2)

$$\begin{aligned} |M_g^v|^2 &= \sum_{n=1}^{100} g_S^{2n-4} (Q^2) N^{n-2} (N^2 - 1) \\ &\times \sum_{i < j} \sum_{perm} \frac{1}{S_{ij}} \langle \psi_i | \alpha^\dagger | \phi_j \rangle. \end{aligned} \quad (2)$$

Since equations are parts of sentences, it is important to use the appropriate punctuation after them.

2. Experiment

This section describes the main elements of the apparatus and procedures used, always referring to the figure that contains the scheme of the experimental setup and/or device schema. Besides, we must provide information about the sample being investigated and, possibly, the way it was obtained and prepared for measurements. Some additional information can be placed on the pictures themselves or in their captions. The information provided in this part of the report must be detailed enough to allow the experiment to be repeated.

The experimental section can be started as follows: The experimental setup is shown in Fig. (1). ⁸⁵Rb ensemble is pumped and probed by linearly polarized light tuned to the low-frequency wing of the Doppler-broadened $F = 3 \rightarrow F' = 0$ transition. Coil producing magnetic field in the y direction is fed with a constant current, while the x and/or z coils are fed with both direct and alternating current for compensation and generation of rotating/oscillating magnetic field. The polarization rotation is measured with a balanced polarimeter and a lock-in amplifier. More details on the experimental setup can be found in [1].

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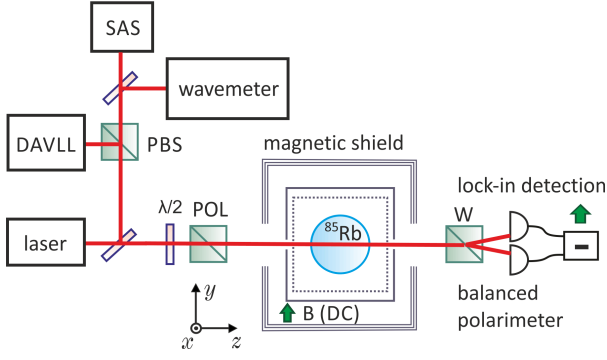


Figure 1: Experimental setup. DAVL – dichroic atomic vapor laser lock, SAS – saturated absorption spectroscopy, PBS – polarizing beam splitter, W – Wollaston prism, $\lambda/2$ – half-wave plate used with a GlanThompson polarizer (POL) for the light power adjustment. The rotation signals are recorded with a computer (not shown).

3. Results and discussion

In this section we present a concise description of data processing, the results obtained at intermediate stages and the final results. Remember to report all your results with appropriate significant digits, units, and uncertainties, e.g. $M_q = (7.13 \pm 0.06) \times 10^{-7}$ kg. The details of determining the uncertainties should be placed in the *Appendix*. The results are usually presented in the form of figures (Fig. 2, 3) and/or tables (Tabel 1) and depending on their size, they may occupy one or two columns in the text. Figures should be well thought out and prepared to maximize their informative content while maintaining transparency. All figures and tables must be properly captioned and referenced in the main text or *Appendices*

If circumstances in an experiment are such that you cannot get your own data (e.g. failure of the apparatus), you may use somebody else's data provided you got permission from the tutor and you acknowledge it in the report.

4. Summary and conclusions

Unlike *Abstract*, this section is not just a summary of the results, but rather a commentary on their scientific significance. It may also include comments on how to improve quality and credibility of measurements. The summary is directed to the reader who became

Table 1: An example table. Be sure to use the appropriate SI units and include the uncertainty of the determined physical quantities.

	r_c (Å)	κr_0		r_c (Å)	κr_0
Cu	0.803(66)	2.55(21)	Sn	0.680(53)	3.70(33)
Ag	0.990(22)	2.71(27)	Pb	0.450(24)	3.76(77)
Tl	0.488(11)	3.55(22)			

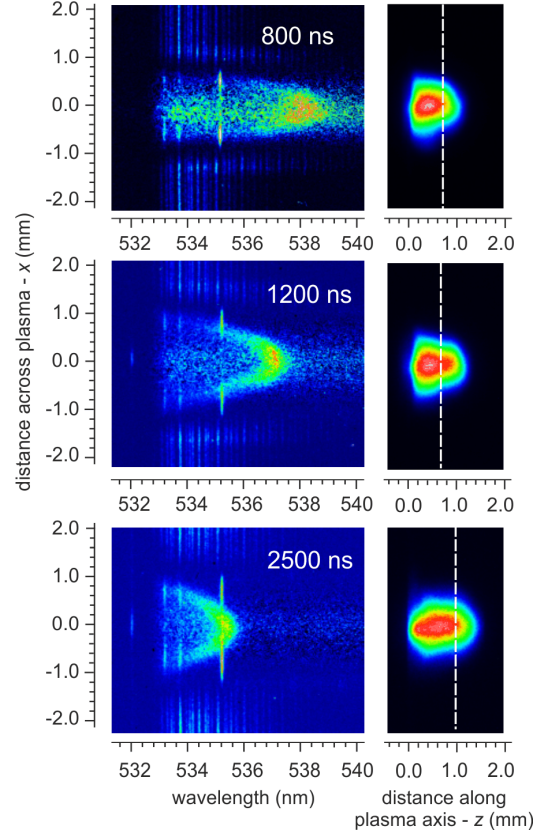


Figure 2: The scattering spectra after subtraction of plasma emission (left) and plasma images (right) registered with the ICCD camera. The TS spectra were measured for the plasma layers indicated by dashed vertical lines. The distance along the plasma plume is measured with respect to the position of the Al target. The ablating laser beam was incident from the right hand side. The broad peaks correspond to the electron feature of TS spectra while narrow lines are components of Raman spectra of Al and Mg within the plasma and of nitrogen molecules outside the plasma volume. All the images are normalized to their maximum intensities.

acquainted with whole paper.

The good practice after printing the report is its correction for errors in spelling and grammar. Nothing so irritates the reviewer as to the carelessness in preparing the manuscript and always works against the author.

Acknowledgments

I am grateful to Diego Maradona for valuable discussions and technical support during the experiment and to Dr. Thomas Moore for making the samples available.

References

- [1] S. Pustelny, L. Busaite, M. Auzinsh, A. Akulshin, N. Leefer, and D. Budker, Phys. Rev. A **92**, 053410 (2015).

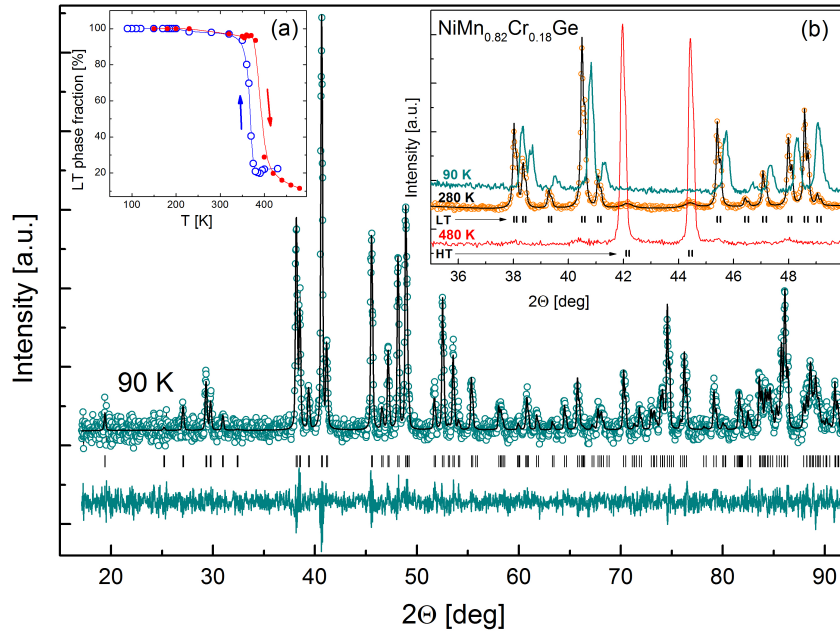


Figure 3: X-ray diffraction pattern of $\text{NiMn}_{0.82}\text{Cr}_{0.18}\text{Ge}$ collected at 90 K. The open circles are for the experimental data, the line shows the Rietveld refinement, the vertical bars mark the Bragg peak positions and the difference between the experimental data and the refinement is plotted in the bottom of the figure. In the insets: (a) temperature dependence of the low temperature phase fraction and (b) comparison of the X-ray patterns collected at 90 K, 280 K and 480 K (the vertical bars mark the Bragg peak positions for the low temperature orthorhombic (LT) and high temperature hexagonal (HT) phases).

- [2] C. Kittel, *Wstęp do fizyki ciała stałego*, PWN 1970, str. 15-91.
- [3] D.C. Phillips, *Advances in Structure Research by Diffraction Methods* **2**, 75 (1996).
- [4] P. Bevington and D. Robinson, *Data Reduction and Error Analysis for the Physical Sciences*, McGraw-Hill, 2003.
- [5] <http://henke.lbl.gov/optical-constants/Xray> interactions with matter.
- [6] Manual for the experiment Z1 (www.2pf.if.uj.edu.pl).

Then, following the law of uncertainty propagation, I calculate the total standard deviation of the period

$$u(T) = \sqrt{S_T^2 + \frac{(\Delta T)^2}{3}} = 0.03458 \text{ s.}$$

Appendix A: L^AT_EX for Windows

Dla studentów używających systemu Windows, M^IKT_EX jest bezpłatną implementacją programów T_EX dostępnym na stronie www.miktex.org.

Appendix B: Calculations of measurement uncertainties

Determining the uncertainty of the pendulum period

To determine the standard uncertainty, I calculate the standard deviation of the mean value

$$S_{\bar{T}} = \sqrt{\frac{(T_i - T_{sr})^2}{n(n-1)}} = 0.009189 \text{ s.}$$