Elsevier instructions for the preparation of a 2-column format camera-ready paper in \LaTeX

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These pages provide you with an example of the layout and style for 100\% reproduction which we wish you to adopt during the preparation of your paper. This is the output from the \LaTeX\ document style you requested.

1. FORMAT

Text should be produced within the dimensions shown on these pages: each column 7.5 cm wide with 1 cm middle margin, total width of 16 cm and a maximum length of 20.2 cm on first pages and 21 cm on second and following pages. The \LaTeX\ document style uses the maximal stipulated length apart from the following two exceptions (i) \LaTeX\ does not begin a new section directly at the bottom of a page, but transfers the heading to the top of the next page; (ii) \LaTeX\ never (well, hardly ever) exceeds the length of the text area in order to complete a section of text or a paragraph.

1.1. Spacing

We normally recommend the use of 1.0 (single) line spacing. However, when typing complicated mathematical text \LaTeX\ automatically increases the space between text lines in order to prevent sub- and superscript fonts overlapping one another and making your printed matter illegible.

1.2. Fonts

These instructions have been produced using a 10 point Computer Modern Roman. Other recommended fonts are 10 point Times Roman, New Century Schoolbook, Bookman Light and Palatino.

2. PRINTOUT

The most suitable printer is a laser printer. A dot matrix printer should only be used if it possesses an 18 or 24 pin printhead (“letter-quality”).

The printout submitted should be an original; a photocopy is not acceptable. Please make use of good quality plain white A4 (or US Letter) paper size. The dimensions shown here should be strictly adhered to: do not make changes to these dimensions, which are determined by the document style. The document style leaves at least 3 cm at the top of the page before the head, which contains the page number.

Printers sometimes produce text which contains light and dark streaks, or has considerable lighting variation either between left-hand and right-hand margins or between text heads and bottoms. To achieve optimal reproduction quality, the contrast of text lettering must be uniform, sharp and dark over the whole page and throughout the article.

If corrections are made to the text, print completely new replacement pages. The contrast on these pages should be consistent with the rest of the paper as should text dimensions and font sizes.

Footnotes should appear on the first page only to indicate your present address (if different from your normal address), research grant, sponsoring agency, etc. These are obtained with the \texttt{\thanks} command.
Table 1
Biologically treated effluents (mg/l)

|                     | Pilot plant | Effluent | Full scale plant | Effluent |
|---------------------|-------------|----------|------------------|----------|
| Total cyanide       | 6.5         | 0.35     | 2.0              | 0.30     |
| Method-C cyanide    | 4.1         | 0.05     | -                | 0.02     |
| Thiocyanide         | 60.0        | 1.0      | 50.0             | < 0.10   |
| Ammonia             | 6.0         | 0.50     | -                | 0.10     |
| Copper              | 1.0         | 0.04     | 1.0              | 0.05     |
| Suspended solids    | < 10.0      |          | < 10.0           |          |

Reprinted from: G.M. Ritcey, Tailings Management, Elsevier, Amsterdam, 1989, p. 635.

3. TABLES AND ILLUSTRATIONS

Tables should be made with $\LaTeX$; illustrations should be originals or sharp prints. They should be arranged throughout the text and preferably be included on the same page as they are first discussed. They should have a self-contained caption and be positioned in flush-left alignment with the text margin within the column. If they do not fit into one column, they may be placed across both columns (using \begin{table*} or \begin{figure*} so that they appear at the top of a page).

3.1. Tables

Tables should be presented in the form shown in Table 1. Their layout should be consistent throughout.

Horizontal lines should be placed above and below table headings, above the subheadings and at the end of the table above any notes. Vertical lines should be avoided.

If a table is too long to fit onto one page, the table number and headings should be repeated above the continuation of the table. For this you have to reset the table counter with \addtocounter{table}{-1}. Alternatively, the table can be turned by 90° (‘landscape mode’) and spread over two consecutive pages (first an even-numbered, then an odd-numbered one) created by means of \begin{table}[h] without a caption. To do this, you prepare the table as a separate $\LaTeX$ document and attach the tables to the empty pages with a few spots of suitable glue.

3.2. Line drawings

Line drawings should be drawn in India ink on tracing paper with the aid of a stencil or should be glossy prints of the same; computer prepared drawings are also acceptable. They should be attached to your manuscript page, correctly aligned, using suitable glue and not transparent tape. When placing a figure at the top of a page, the top of the figure should be at the same level as the bottom of the first text line.

All notations and lettering should be no less than 2 mm high. The use of heavy black, bold lettering should be avoided as this will look unpleasantly dark when printed.

3.3. Black and white photographs

Photographs must always be sharp originals (not screened versions) and rich in contrast. They will undergo the same reduction as the text and should be pasted on your page in the same way as line drawings.

3.4. Colour photographs

Sharp originals (not transparencies or slides) should be submitted close to the size expected in publication. Charges for the processing and printing of colour will be passed on to the author(s) of the paper. As costs involved are per page, care should be taken in the selection of size and shape so that two or more illustrations may be fitted together on one page. Please contact the Technical Editor in the Camera-Ready Publications Department at Elsevier for a price quotation and layout instructions before producing your paper in its final form.
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Figure 1. Good sharp prints should be used and not (distorted) photocopies.

Figure 2. Remember to keep details clear and large enough.

4. EQUATIONS

Equations should be flush-left with the text margin; \LaTeX ensures that the equation is preceded and followed by one line of white space. \LaTeX provides the document-style option fleqn to get the flush-left effect.

\[ H_{\alpha\beta}(\omega) = E^{(0)}_\alpha(\omega)\delta_{\alpha\beta} + \langle \alpha|W_\pi|\beta \rangle \]  

(1)

You need not put in equation numbers, since this is taken care of automatically. The equation numbers are always consecutive and are printed in parentheses flush with the right-hand margin of the text and level with the last line of the equation. For multi-line equations, use the eqnarray environment. For complex mathematics, use the \texttt{AMSLaTeX} package.

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1. S. Scholes, Discuss. Faraday Soc. No. 50 (1970) 222.
2. O.V. Mazurin and E.A. Porai-Koshits (eds.), Phase Separation in Glass, North-Holland, Amsterdam, 1984.
3. Y. Dimitriev and E. Kashchieva, J. Mater. Sci. 10 (1975) 1419.
4. D.L. Eaton, Porous Glass Support Material, US Patent No. 3 904 422 (1975).

References should be collected at the end of your paper. Do not begin them on a new page unless this is absolutely necessary. They should be prepared according to the sequential numeric system making sure that all material mentioned is generally available to the reader. Use \texttt{\cite} to refer to the entries in the bibliography so that your accumulated list corresponds to the citations made in the text body.

Above we have listed some references according to the sequential numeric system [1–4].
QED2 as a testbed for interpolations between quenched and full QCD

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Lattice QED2 with the Wilson formulation of fermions is used as a convenient model system to study artifacts of the quenched approximation on a finite lattice. The quenched functional integral is shown to be ill-defined in this system as a consequence of the appearance of exactly real modes for physical values of the fermion mass. The location and frequency of such modes is studied as a function of lattice spacing, lattice volume, topological charge and improved action parameters. The efficacy of the recently proposed modified quenched approximation is examined, as well as a new approach to the interpolation from the quenched to full dynamical theory employing a truncated form of the fermion determinant.

1. Introduction

In this talk, some general features of the Wilson-Dirac spectrum in quenched lattice gauge theory are discussed using 2-dimensional QED as a convenient model system \cite{1}. The specific focus will be the dependence of the real part of the spectrum on the parameters of the theory. The nonexistence of the quenched functional integral is found to arise from a complicated analytic structure induced by these real modes. The relation of quenched, pole-shifted \cite{2} and full dynamical amplitudes is also discussed. Finally, the usefulness, accuracy and feasibility of an interpolating determinant approach to the full theory can be studied in detail in this model.

2. General Features of the Wilson-Dirac spectrum

In QED2 quark propagators are inverses of a matrix $D - rW + m \equiv \mathcal{M} + m$, with $D$, $W$ and $m$ the naive Dirac matrix, $W$ the Wilson term, and $m$ a quark mass parameter:

$$\mathcal{M} \equiv D - rW \quad \quad (1)$$

$$D_{\bar{m}\bar{n},a\bar{b}} = \frac{1}{2}(\gamma_{\mu})_{ab}U_{\bar{m}\bar{n},\mu}\delta_{\bar{m},\bar{n}+\bar{\mu}}$$

$$W_{a\bar{m},b\bar{n}} = \frac{1}{2}\delta_{ab}(U_{\bar{m}\bar{n},\mu}\delta_{\bar{m},\bar{n}+\bar{\mu}} + U_{\bar{m}\bar{n},\bar{\mu}}\delta_{\bar{m},\bar{n}-\bar{\mu}}) \quad (2)$$

$$\left\{\begin{array}{lcl}
\text{(1)} & \text{The norm of the quadratic form } \mathcal{M} \text{ is less than or equal to 2 for arbitrary gauge fields } \mathcal{B}, \text{ so the spectrum is contained inside a circle of radius 2 in the complex plane. In fact, a typical spectrum (see Fig. 1) has an elliptical shape with four critical branches, two in the center and one on either side. Conventionally the left critical branch represents the chiral (zero fermion mass) limit.} \\
\text{(2)} & \text{The secular polynomial for } \mathcal{M} \text{ has real coefficients and only even terms, so eigenvalues necessarily appear as real doublets } \lambda, -\lambda \text{ or as complex quartets } \lambda, \lambda^*, -\lambda, -\lambda^*. \text{ In particular, the appearance of exactly real eigenvalues (despite the fact that } \mathcal{M} \text{ is not a normal matrix) is generic, and such eigenvalues persist in finite neighborhoods of any gauge configuration point with a real mode. (Note the 2 exactly zero modes associated with each critical branch in Fig. 1).} \\
\text{(3)} & \text{The appearance of exactly real modes for}
\end{array}\right.$$
\[-2 \leq \lambda \leq -\frac{1}{2\kappa},\] (i.e. for physical naive fermion masses using the left critical branch) will lead to nonintegrable singularities in the quenched functional integral involving lattice Wilson-Dirac propagators. The integral can be defined by analytical continuation from the nonsingular region $|\lambda| > 2$, but the region inside the spectral ellipse is thoroughly infested with complicated branch cuts connecting a large number of branch points.

A pinch argument shows that such branch points arise at any eigenvalue of $M$ for gauge configurations where the link variables $U$ are either +1 or -1. The noisy behavior of quenched simulations can be traced directly to this pathology.

The above statements are analytically demonstrable, but even more can be learned from detailed explicit simulations. For example:

(4) The integer part of the topological charge $Q_1 = \frac{1}{4\pi} \sum_P \sin (\theta_P)$, (where $\theta_P$ is the plaquette angle for plaquette $P$), tracks quite closely the number of exactly zero modes per critical branch.

Transitions between different topological charge sectors in the course of the simulation are accompanied by movement of complex eigenvalue quartets towards and then along the real axis.

(5) Histograms of the exactly real modes accumulated over many (typically 1000) decorrelated configurations for different beta values, but keeping the physical lattice volume fixed show that the spread of real modes into the physical mass region becomes acute at strong coupling, and that the probability at fixed physical fermion mass of encountering exceptional configurations in which a nearby real propagator pole introduces large fluctuations in measured hadronic amplitudes decreases rapidly as beta is increased (see Fig. 2).

(6) With increasing lattice volume at fixed $\beta$, the probability of encountering an exceptional configuration as one approaches the left critical line decreases with increasing volume if one keeps a fixed offset from the critical line to maintain a fixed physical quark mass. However, exceptional configurations necessarily appear at any volume once one goes sufficiently close to the critical point.

(7) The frequency and distribution of exactly real modes is not substantially affected by a clover improved action. Of course, on any individual configuration, the location of real modes (if present) will change with the value of the clover coefficient chosen. But the statistical noise introduced by exceptionals in any large ensemble remains.

3. Comparison of Quenched, MQA and Full Dynamical Simulations

Recently, we have proposed a modified quenched approximation (MQA) in which the quenched functional integral is made well-defined by a pole-shifting procedure which incorporates the correct spectral behavior in the continuum limit (see [4] for a more detailed description). QED2 offers a convenient model for comparison of naive quenched, MQA and full dynamical results. A typical result is shown in Fig. 3, where the pseudoscalar correlator (“pion propagator”) is shown at a bare quark mass of 0.08 (at $\beta=4.5,$
10x10 lattice) for these 3 cases. The statistical noise in the quenched correlators is essentially eliminated in the MQA results, which also are found to interpolate between the naive quenched and full dynamical results. This is gratifying - the MQA, in addition to rendering quenched amplitudes meaningful on coarse lattices, appears to move us closer to the unquenched theory.

Figure 3. Pseudoscalar correlators in QED2-quenched, MQA and full dynamical

4. Interpolating Determinant Approach to Dynamical Fermions

We have recently begun a study of an alternative approach to the problem of interpolating between quenched and unquenched gauge theory, inspired by the insights gained in the MQA work on the role of small eigenvalues. The idea is to separate off and include explicitly in the simulation the infrared contributions to the determinant. In superrenormalizable QED2, the lowest $2N_{\lambda}$ eigenvalues contribute essentially all of the fluctuations to $\ln \det(\gamma_5(M-m))$, as indicated in Fig.4, while the remaining 200-2$N_{\lambda}$ (on a 10x10 lattice) hardly contribute to the determinantal variation. As a consequence correlators computed using just the lowest 10% of the spectrum are essentially exact (see Fig.5).

In QCD4 the UV part of the quark spectrum certainly contributes importantly to a renormalization of coupling, visible as a substantial shift of scale in lattice amplitudes. However, work in progress shows that all the important infrared physics (e.g. the correct chiral structure, eliminating quenched chiral logs), say up to a scale of 300 MeV, can be built in by inclusion of a few hundred eigenvalues of $\gamma_5(M-m)$ which are readily accessible by a Lanczos scheme. It seems possible that the remaining determinant effects not simply reducible to a change of scale may be included at the end by a reweighting scheme, or perhaps by using an appropriate loop representation for the intermediate part of the quark spectrum. A study of these issues in QCD4 is in progress.

REFERENCES

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