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An Approach to Automatic Indexing of Scientific Publications in High Energy Physics for Database SPIRES HEP

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Abstract

We introduce an approach to automatic indexing of e-prints based on a pattern-matching technique making extensive use of an Associative Patterns Dictionary (APD), developed by us. Entries in the APD consist of natural language phrases with the same semantic interpretation as a set of keywords from a controlled vocabulary. The method also allows to recognize within e-prints formulae written in TEX notations that might also appear as keywords. We present an automatic indexing system, AUTEX, which we have applied to keyword index e-prints in selected areas in high energy physics (HEP) making use of the DESY-HEPI thesaurus as a controlled vocabulary.

1 Introduction

Indexing is considered classically as an evaluation of documents, leading to its content-based representation, which could subsequently be accessed using a descriptor-based information retrieval system. These descriptors (keywords) are taken as a rule from a well-defined and controlled vocabulary. One expects that this controlled vocabulary is periodically updated to be *en vogue*, i.e., it would reflect new fields, and new trends and innovations within the established fields.

Intellectual indexing implies at least two essential steps: the conceptual grasp of the content of a document (content analysis), and transcribing the content in terms of index descriptors (taken, for example, from a thesaurus). The central point is that the intellectual indexing process requires an understanding by a human indexer of the "aboutness" [Chung 1998] of a document being indexed. Historically, this was the only method of indexing the literature, as all publishing and related bibliographical work was done with papers. This classic form of document analysis is still widely used, and is particularly important in the circumstances where the texts are available in a non-electronic form or for non-text documents (pictures, photographs, films etc.). The down side of the intellectual method is that it is expensive, subject-oriented, and hence localized, and time consuming. Moreover, human-based judgment errors can not always be avoided.

In the case of High Energy Physics (HEP), which is the primary area of research we shall concentrate on, keyword indexing has been done at the German High Energy Physics Laboratory DESY (Deutsches Elektronen-Synchrotron) [DESY] in Hamburg, which has developed and maintained the High Energy Physics Index (HEPI) since 1963. The DESY-HEPI keywords [HEPI] are included in all records (published papers, preprints, conference proceedings and books) in the HEP literature database called SPIRES (Stanford Public Information REtrieval System), maintained at the high energy physics laboratory SLAC (Stanford Linear Accelerator Center) in California [SPIRES]. This keyword indexing has been done exclusively using the so-called intellectual method in the Scientific Documentation Group at DESY, involving a team which includes some members with HEP background. The thesaurus used in HEPI is based on approximately 2500 terms, and is occasionally updated. With the growing use of computer-based methods and the rapid increase in the number of scientific publications, most of which are prepared in electronic form, and a well-maintained central repository of e-prints in HEP and related fields now based at Cornell University [Ginsparg 1991], there is an overriding need to develop methods of automatic indexing. In fact, automatic indexing is in the long term *the only realistic and economically viable method* of keyword indexing scientific documents.

However, despite all the technological progress and, what concerns HEP and several related fields, the availability of e-prints from the electronic archives dating back to the pioneering work of Ginsparg done at the Los Alamos National Laboratory in New Mexico in 1991 [Ginsparg 1991], there is no fully automatic indexing system in HEP available yet. In the recent past, some progress in this direction has been made at CERN (the European Laboratory for Particle Physics) in Geneva. The first of these approaches called SOCRATES was an attempt to incorporate software for automatic indexing [Dallman/Meur 1999], based on constructing a set of the longest noun-type phrases from the abstracts of documents. This approach was, however, abandoned at the end of 2000 due to the difficulties of integrating its software into the database system of the CERN library. This was followed by a second research and development (R&D) project called HEPindexer [Ráez/Dallman 2001], in which the first step aimed at the generation of the DESY-HEPI keywords has been implemented following a statistical method. The

results of HEPindexer, which was trained on some 2400 high energy physics papers and tested so far on some 1200 additional documents, is quite impressive in that the results were close to 60% in precision and recall benchmarked against the HEPI-SPIRES method of keyword indexing [SPIRES]. However, HEPindexer is not yet in use for professional indexing of the HEP documents.

In this report we describe our approach to automatic indexing of HEP e-prints based on *associative pattern* matching. Central to our approach is the *Associative Patterns Dictionary*, which we have developed and encoded. Our software package, AUTEX (AUTomatic indEXer) has been tested so far in a limited area of HEP, namely neutrino physics, astrophysics and physics of the axion. This choice is based on our expertise and HEP background. The goal of AUTEX indexer is to take a document (an e-print) as input and represent its contents as a set of keywords from the DESY-HEPI thesaurus. Judging from the number of e-prints in these fields, our project covers at present about 15% of the e-prints in HEP. This is also reflected in the number of the keywords presently encoded in the AUTEX database (approximately 550) compared to approximately 2500 of the DESY-HEPI thesaurus. We have tested our software package on about 300 e-prints in these fields and have compared the results of our automatic indexing with the ones generated using the SPIRES-HEP literature database. Our system can be accessed also by remote users and is already in a position to be used for indexing work in the stated areas of HEP. We describe the salient features of our automatic indexer AUTEX, showing some representative results of the index reports on e-prints together with comparisons with the SPIRES HEP generated intellectual indexing results. Templates of the AUTEX screen at various intermediate steps of automatic indexing are also shown. In future, we plan to enlarge the applications to cover the entire fields of HEP, astrophysics and cosmology, and to include additional features in the indexing reports such as the titles of the papers, authors names, and their institutional affiliations. Further details and AUTEX report results can be seen in Ref. [Vassilevskaya 2002].

2 AUTEX - an Automatic Indexer of High Energy Physics Documents

We start by describing the basic components of the AUTEX system. These include the terminology, the *Associative Patterns Dictionary*, an introduction to the basic principle on which AUTEX is based, and the user interface.

2.1 Terminology

To begin, one should outline some definitions.

Keywords List

Keywords List is a subset of a controlled vocabulary. In the case of high energy physics it is assumed to be covered by DESY-HEPI thesaurus. A *keyword* can be either a separate word:

astrophysics
neutrino

or a combination of some words:

dispersion relations
interpretation of experiments.

Keychain

Keychain is composed of keywords written in one line and joined by a comma and a blank as a delimiter:

$$\overbrace{\underbrace{\textbf{astrophysics}}_{keyword}}^{keychain}$$

$$\overbrace{\underbrace{\textbf{neutrino}}_{keyword}, \underbrace{\textbf{magnetic moment}}_{keyword}}^{keychain}$$

$$\overbrace{\underbrace{\textbf{plasmon}}_{keyword}, \underbrace{\textbf{longitudinal}}_{keyword}, \underbrace{\textbf{dispersion relations}}_{keyword}}^{keychain}$$

...

In principle the system is able to construct a keychain of any length (any number of keywords). The keychain of length one is just a keyword. At the moment, keychains of length no more than two are used *de facto* within the Scientific Documentation Group at DESY. It is keychains – not keywords – that are assigned to a document during indexing process. The resulting set of keychains forms a document index that is incorporated into the SPIRES-HEP database.

Associative Patterns Dictionary (APD)

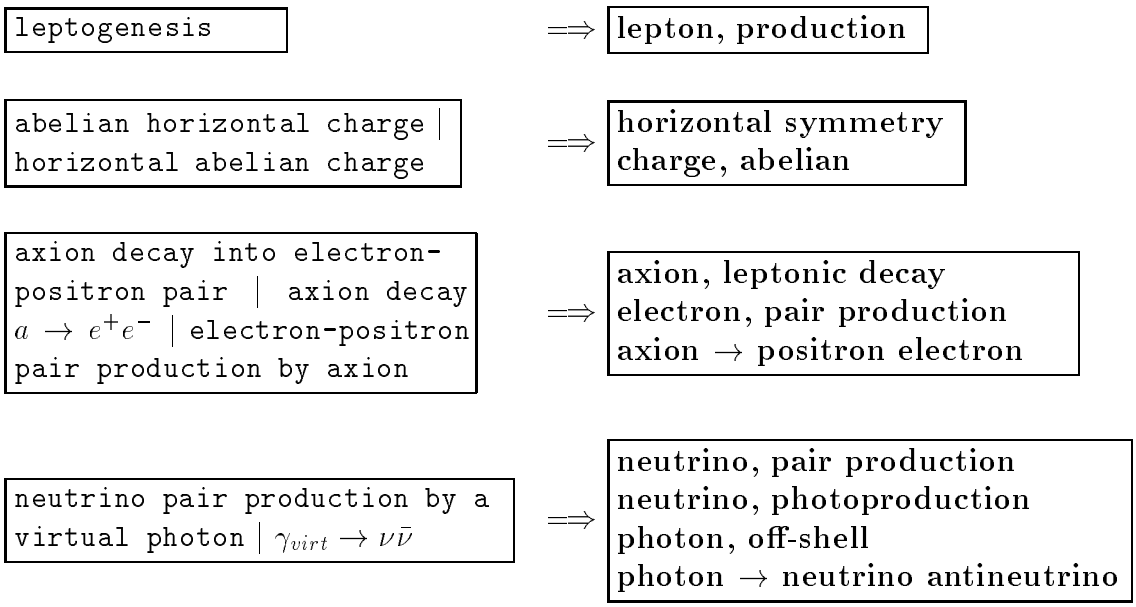
In its simplest form an **associative pattern** is thought of as any English phrase that might also include a formula written in TEX notations:

```
astrophysics
neutron stars
search for galactic dark matter
$\nu \to \nu \gamma$
axion decay $\a \to e^+ e^-$.
```

Given an associative pattern, we assign to it a set of keychains defining the *meaning* of this pattern. That is, one gets a semantic interpretation of the pattern in terms of keychains from the controlled vocabulary. Applying an alternation metasymbol | (vertical bar) makes it possible to consider multiple associative patterns of the form:

`energy dissipation | dissipation of energy | energy is dissipated.`

In most cases each constituent phrase in an associative pattern is a noun phrase. However, in principle, *any* other phrase is allowed. Here are some examples of how the APD entrance may look like:



Therefore, each entrance in the APD represents a relation, i.e., an *association* between an *idea* and a set of index terms.

2.2 How does AUTEX work?

As already stated, the AUTEX indexer takes a document (an e-print) as input and represents its content as a set of keywords from DESY-HEPI thesaurus. Of course, this thesaurus is a default option currently and as the applications increase, the DESY-HEPI can be replaced by another thesaurus. Rather than thinking of a document as natural language input text (which is additionally wrapped by TEX commands), we treat it as a stream of characters and apply the pattern-matching technique. At the present stage, the AUTEX system does not perform aspects of natural language processing which traditionally include part-of-speech tagging and syntactic analysis. Instead, each associative pattern from the APD tries to match a document content. If it succeeds, the corresponding set of keychains, associated with this pattern, is added into a document index. So, the AUTEX indexer does not distinguish whether a phrase is a noun phrase or it is something

else. It just matches patterns.

The indexer actually consists of two phases of operation: *preprocessing* and *pattern matching*. The first one in our case involves undertaking some *preprocessing* of the input text. The system provides a set of built-in *pointers* that enable us to specify which parts of the article to work out. Currently, the following six pointers are available: "title", "abstract", "caption", "section", "conclusions", and "full-text". Once a pointer is set, the system parser extracts the corresponding part of the document and includes it into the text to be processed. These parts of the text usually (though not always) contain an important information on the purpose of investigations and/or the results obtained in the paper. So, reading these parts of the article is expected to lead to information on the text relevant for keyword indexing. Of course, multiple choice is possible and is used in the actual indexing work presented here. Note also that the "section" pointer instructs the parser to fetch titles of the various sections (not the section contents themselves) including the titles of "subsections", "subsubsections", etc. as well.

Another goal of the preprocessing is to prune irrelevant TEX commands from each part to be pointed out. For example, the pattern `strong magnetic field` has to match the occurrence `{\it strong} magnetic field` as well.

2.3 User Interface

For the AUTEX indexer to work it has to be supplied with an appropriate look up dictionary – APD in our case. It is obvious, that the APD is of crucial importance for an effective and correct automatic indexing. In particular, how the APD is populated and maintained will play a central role in indexing. At the current stage of development of the AUTEX project, APD is populated "by hand". This work is done by a subject specialist making use of a graphic user interface provided by the system. This interface enables navigation across the system and facilitates the management of Keyword List, Keychain List, APD, and the indexer itself. For example, within APD Manager, the APD records can be accessed using a flexible filter. The filter options include keying of a truncated string of characters, alphabetical selection, and keychain selection. This enables one to select all patterns associated with a given set of keychains. Similar filters are provided in Keyword Manager and Keychain Manager as well.

3 Pattern Matching

The patterns used in AUTEX pattern matching are, in fact, regular expressions in their simplest form. Let us suppose that we are creating a pattern that will succeed if an input text is about massless neutrino. It may be seen, for example, that the pattern `massless neutrino` will not match the occurrence `massless chiral neutrinos`. Such

cases are easily resolved if one introduces the following regular expression

```
massless[ \w]+neutrinos?
```

where the metacharacter `[]` and the quantifiers `?` and `+` have their standard meaning in the extended regular expression syntax that is supported by egrep routine. The backslashed metacharacter `\w` matches a single alphanumeric character. This pattern will succeed whatever words occur between the words `massless` and `neutrino`, but it will still fail on the phrase, for example, `the neutrino is assumed to be massless`. To match this phrase too, we modify our pattern to yield

```
massless[ \w]+neutrinos?|neutrinos?[ \w]+massless
```

This improves pattern matching. However, it will occasionally also process English text in which a certain pattern is matched though the sense in which these words are used is different than what a certain *keychain* implies. For example, one may encounter the following text in a document: `neutrino decays into some particles one of which has to be massless`. The last pattern given above will match this text. However, this will be a wrong matching in the sense of the content, as the text does not discuss massless neutrino but rather a massless particle which is the decay product of a neutrino.

Therefore, if we want that our pattern does not miss any relevant sentence about massless neutrino and all matches correctly depict the content of a document, then one has to add further discriminatory characteristics in the pattern matching engine. In particular, this engine has to be able to first understand the grammar of the sentence. Regular expressions are extremely powerful tool. However, they are not sufficient for grammar understanding. So, we must integrate into the system lexical and syntactic analyzers of English. The idea is to identify in the original text some constituents so that they will be recognized by a limited set of associative patterns, filtering out peripheral text portions. There is an additional complication in our case due to the TEX formulae. This requires further development work and we hope to return to this problem in a future publication.

Note that we stay within the framework based on an human-made APD rather than on any statistical model. That is, each associative pattern is built by a human – a subject specialist – and each association is assigned by an expert. This approach results in rather accurate and reliable index. Our first experiments show that, at this stage, only a few index terms are lost. The system can be sufficiently trained eventually to reduce this loss to a bare minimum. We have striven at reducing the appearance of redundant or irrelevant terms in the index, and our studies show that in this we have largely succeeded.

4 Results and Concluding Remarks

We conclude in this section by showing some representative results from the AUTEX indexer. The results of keyword indexing ten documents from the arXiv.org e-print archive

are shown in Appendix A. The indexing reports from the AUTEX indexer are compared with the already existing SPIRES HEP reports, both of which use the DESY-HEPI thesaurus. The papers discuss mostly neutrino physics, and in one case physics of the axion. Many more such comparisons can be seen in Ref. [Vassilevskaya 2002]. These comparisons show that the AUTEX indexer does a comprehensive job in indexing e-prints, and some of the keywords in the AUTEX reports are missing from the SPIRES HEP generated reports. Certainly, there is some room for improvement in the AUTEX system as well, but the efficiency already reached in the areas covered by AUTEX is very high.

We show some templates of the AUTEX screen at important stages of automatic indexing. Figs. 1 and 2 show the examples of the user interface screens corresponding to the two Managers called *Keyword Manager* and *Keychain Manager*, respectively. The *Article Manager*, whose template from the AUTEX screen is shown in Fig. 3, enables one to upload an article file, set up the pointers mentioned in section 2, submit selected articles in batch mode, and control the resulting index reports. The AUTEX report includes the article index along with the information which indicates from which parts of the article (title, abstract, etc.) each index term stems. A typical indexing result is shown in Fig. 4.

Within the AUTEX project, the high priority for us is to enlarge the applications (done by enlarging the dictionary APD) to cover the entire field of high energy physics, cosmology and astrophysics. This is a straight forward though time-consuming step. However, the results achieved so far are very encouraging and we trust that the goal of developing a completely automatic system of indexing and retrieval of all e-prints in the fields of HEP, astrophysics and cosmology can be achieved. Already at its present stage AUTEX is a useful tool, and it can be used to help in indexing e-prints in some areas of HEP and astrophysics.

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[Vassilevskaya 2002] Vassilevskaya, L. A.; An Approach to Automatic Indexing of Scientific Publications in High Energy Physics for Database SPIRES-HEP; DESY Report DESY L-02-01 , November 2002.

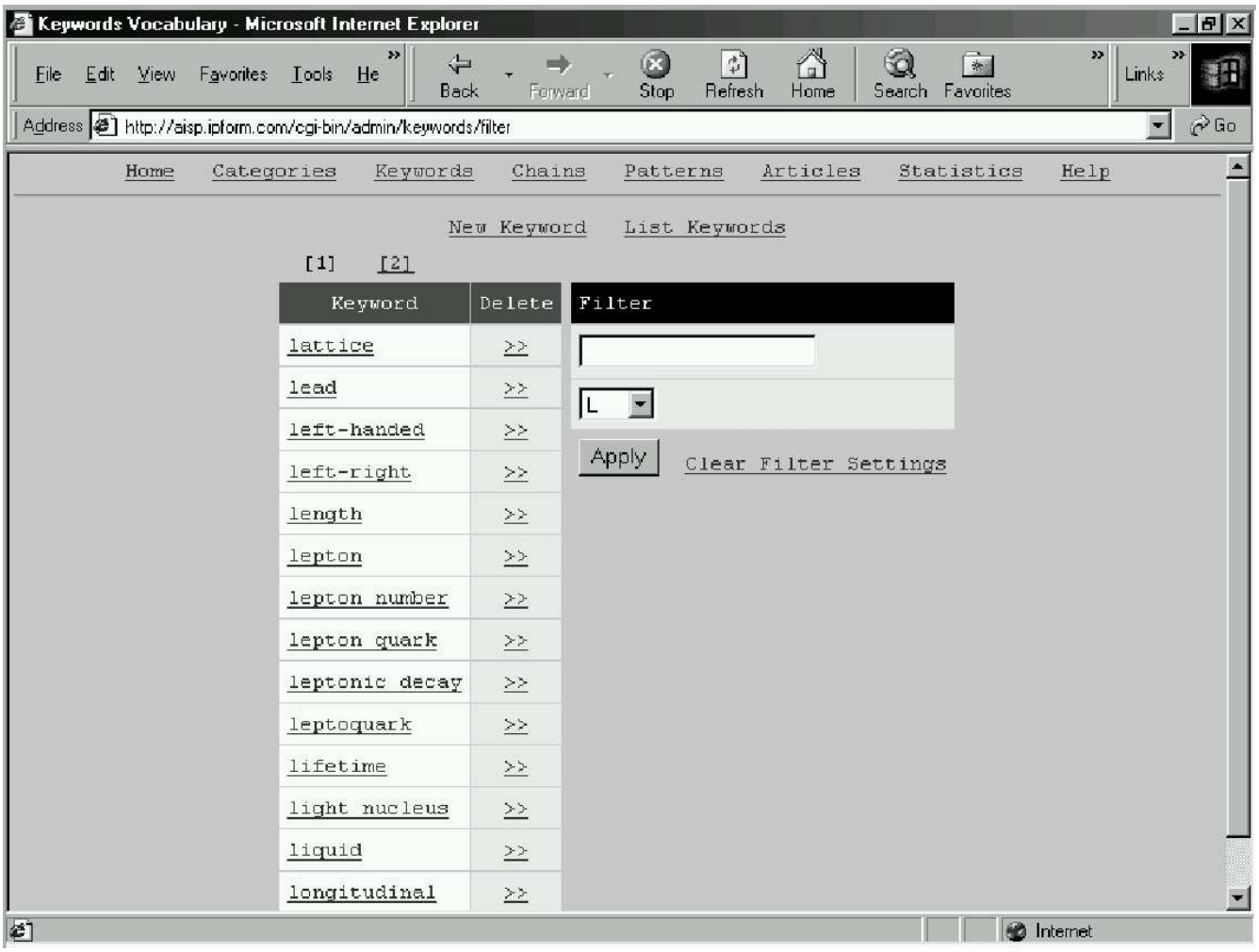

Figure 1: Base screen of the AUTEX Keyword Manager. Keywords are browsed in the most convenient way as a filtered list (shown on the left). The filter has two options: 1) one can choose a letter from the alphabet popup menu for the system to select all keywords starting from this letter (here, the letter L), or 2) one can specify a truncated string (more than one character). In this case, the system will return the list of keywords with these characters as leading. If both filter options are set, the list of keywords will satisfy both of them (logical AND operation).

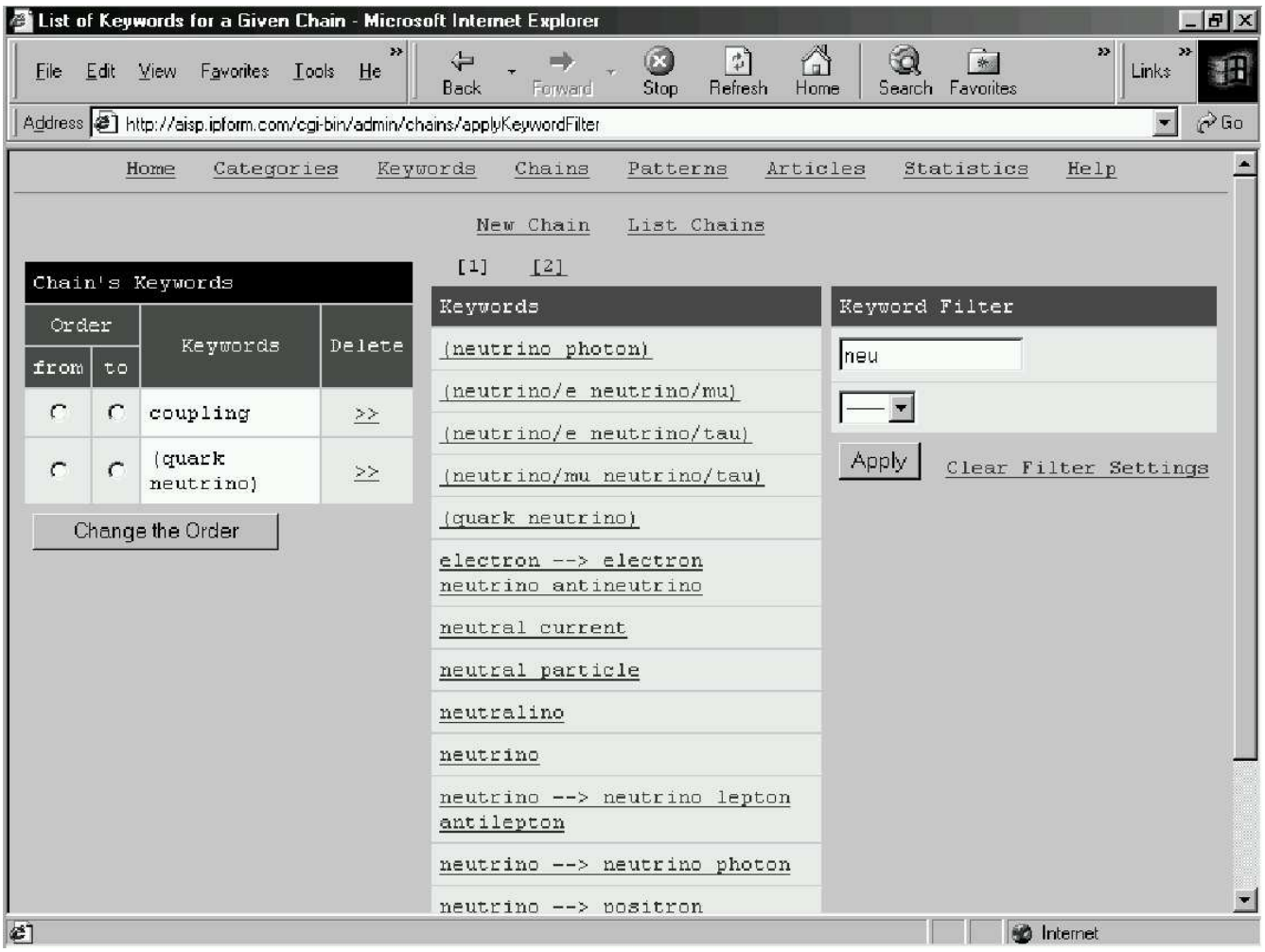

Figure 2: A template from the AUTEX screen showing a keychain creation/modification. One can compose a keychain of any length (any number of keywords) and change the order of keywords within the keychain. To add a keyword into a chain, one has to just press this keyword from the filtered list. This keyword immediately appears in the chain.

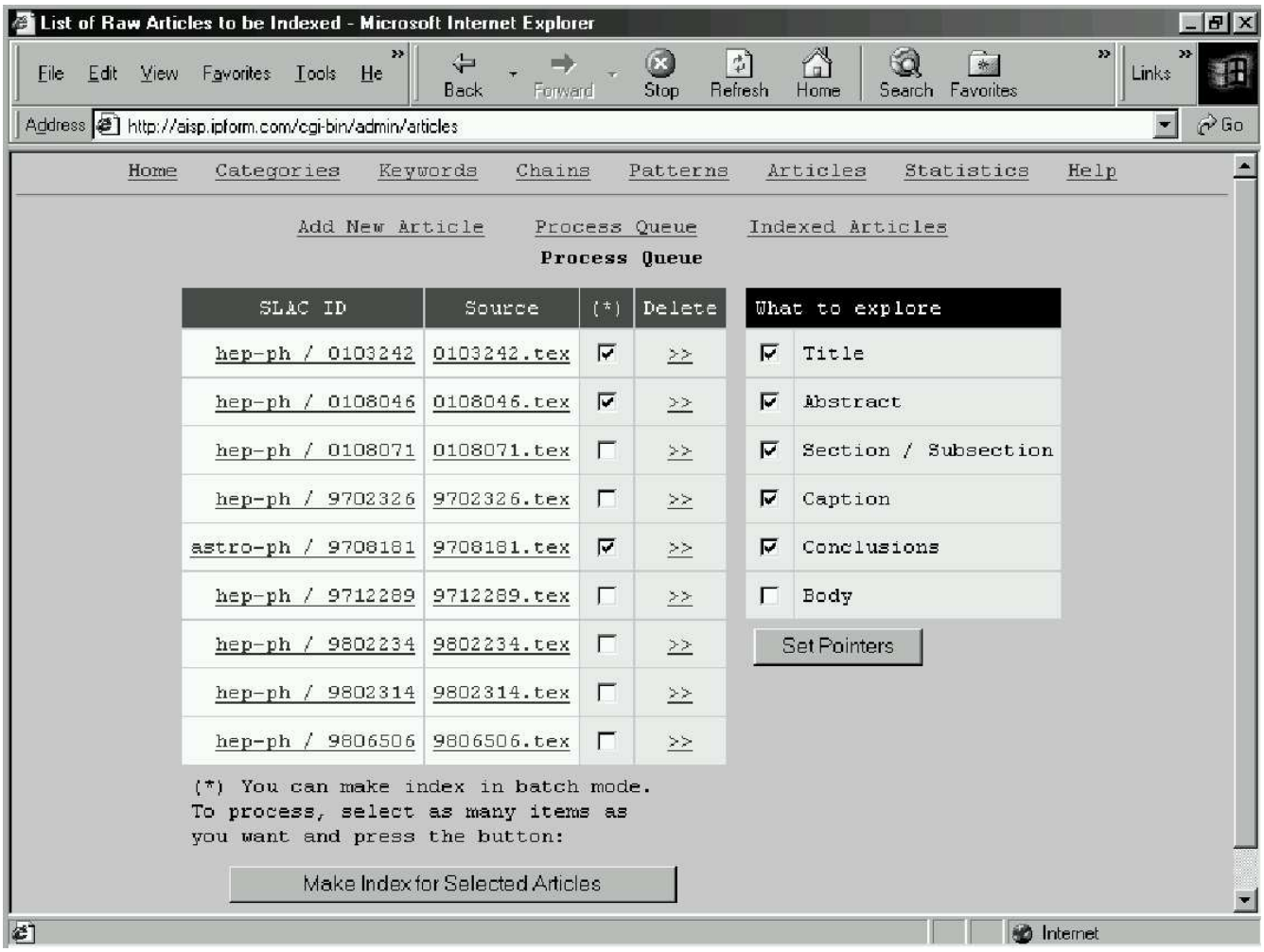

Figure 3: A template from the AUTEX screen, showing a typical setup with multiple pointers along with the process queue, that is a list of references to the e-prints that have already been uploaded into the system, but not indexed yet. The e-prints from the process queue then can be indexed in the batch submission mode.

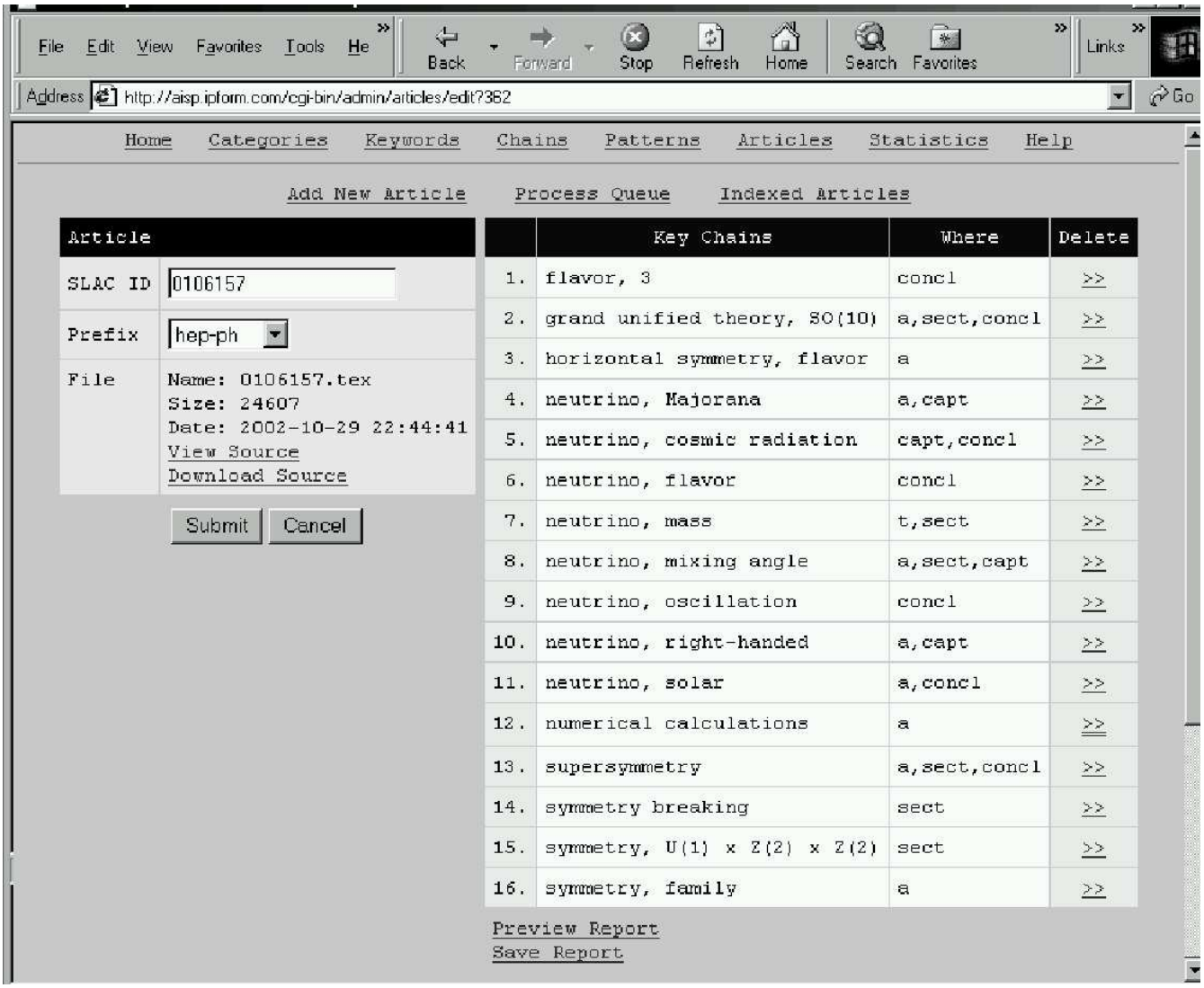

Figure 4: A template from the AUTEX screen, showing the results of the indexed e-print (here hep-ph/0106157). The results can be previewed, corrected, printed, and stored in a file. One can edit an article profile that includes, at present, the SLAC ID and prefix. In future, article title, authors names and addresses are planed to be incorporated into the profile.

A Appendix: AUTEX Reports (Examples)

In this Appendix, we present some representative reports on subject keyword indexing generated by our automatic indexing system AUTEX and compare them with the already existing SPIRES reports. In all these examples, the papers refer to their E-Print archive numbers. The symbol "0" at the end of some reports means that this particular *keychain* has no relation to the paper. The *keychains* written below the horizontal line in some reports indicate mismatching *keychains* between the AUTEX and SPIRES reports.

A.1 hep-ph/0106157

Title: GUT implications from neutrino mass

Abstract

An overview is given of the experimental neutrino mixing results and types of neutrino models proposed, with special attention to the general features of various GUT models involving intra-family symmetries and horizontal flavor symmetries. Many of the features are then illustrated by a specific $SO(10)$ SUSY GUT model formulated by S.M. Barr and the author which can explain all four types of solar neutrino mixing solutions by various choices of the right-handed Majorana mass matrix. The quantitative nature of the model's large mixing angle solution is used to compare the reaches of a neutrino super beam and a neutrino factory for determining the small U_{e3} mixing matrix element.

AUTEX Report:	SPIRES Report:
neutrino, mass	`neutrino, mass`
grand unified theory, SO(10)	`grand unified theory, SO(10)`
symmetry, $U(1) \times Z_2 \times Z_2$	`symmetry, $U(1) \times Z_2 \times Z_2$`
supersymmetry	`supersymmetry`
horizontal symmetry, flavor	`horizontal symmetry, flavor`
symmetry, family	
symmetry breaking	`symmetry breaking`
neutrino, mixing angle	`neutrino, mixing angle`
neutrino, right-handed	
neutrino, Majorana	
neutrino, flavor	
flavor, 3	
neutrino, solar	`neutrino, solar`
neutrino, cosmic radiation	
neutrino, oscillation	`neutrino, oscillation`
numerical calculations	`numerical calculations`

A.2 hep-ph/0103176

Title: Neutrino kinetics in a magnetized dense plasma

Abstract

The relativistic kinetic equations (RKE) for lepton plasma in the presence of a strong external magnetic field are derived in Vlasov approximation. The new RKE for the electron spin distribution function includes the weak interaction with neutrinos originated by the axial vector current ($\sim c_A$) and provided by the parity nonconservation. In a polarized electron gas Bloch equation describing the evolution of the magnetization density perturbation is derived from the electron spin RKE being modified in the presence of neutrino fluxes. Such modified hydrodynamical equation allows to obtain the new dispersion equation in a magnetized plasma from which *the neutrino driven instability of spin waves* can be found. It is shown that this instability is more efficient e.g. in a magnetized supernova than the analogous one for Langmuir waves enhanced in an isotropic plasma.

AUTEX Report:	SPIRES Report:
kinetics, relativistic	`neutrino, kinematics`
lepton, plasma	`lepton, plasma`
plasma, magnetic	
magnetic field, external field	`magnetic field, external field`
magnetic field, high	`magnetic field, high`
Vlasov equation	`Vlasov equation`
electron, spin	`electron, spin`
neutrino, interaction	`neutrino electron, interaction`
current, axial-vector	
parity, violation	
electron, gas	`electron, gas`
electron, polarization	`electron, polarization`
density, perturbation	`density, perturbation`
neutrino, beam	`neutrino, beam`
neutrino, flux	
dispersion relations	`dispersion`
stability	`stability`
astrophysics, supernova	
lepton, current	
current, conservation law	
	`neutrino, form factor`
	`neutrino, charge`
	`charge, induced`

A.3 hep-ph/0106085

Title: Models of neutrino masses and mixings

Abstract

We briefly review models of neutrino masses and mixings. In view of the existing experimental ambiguities many possibilities are still open. After an overview of the main alternative options we focus on the most constrained class of models based on three widely split light neutrinos within SUSY Grand Unification.

AUTEX Report:	SPIRES Report:
neutrino, mass	`neutrino, mass`
neutrino, mixing angle	
neutrino, flavor	`neutrino, flavor`
flavor, 3	
flavor, 4	
mass, texture	
hierarchy	`hierarchy`
lepton number, violation	`flavor, violation`
supersymmetry	`supersymmetry`
grand unified theory, SU(5)	`grand unified theory, SU(5)`
grand unified theory, SO(10)	`grand unified theory, SO(10)`
space-time, higher-dimensional	`space-time, higher-dimensional`
horizontal symmetry, U(1)	`horizontal symmetry`
charge, abelian	
seesaw model	
neutrino, oscillation	`neutrino, oscillation`
neutrino, sterile	`neutrino, sterile`
neutrino, solar	
neutrino, right-handed	
neutrino, Dirac	
neutrino, Majorana	
MSW effect	
astrophysics, missing-mass	
	`neutrino, mass difference`

A.4 hep-ph/0107217

Title: Photon damping caused by electron-positron pair production in a strong magnetic field

Abstract

Damping of an electromagnetic wave in a strong magnetic field is analyzed in the kinematic region near the threshold of electron-positron pair production. Damping of the electromagnetic field is shown to be noticeably nonexponential in this region. The resulting width of the photon $\gamma \to e^+e^-$ decay is considerably smaller than previously known results.

AUTEX Report:	SPIRES Report:
photon, absorption	
photon, leptonic decay	
electron, pair production	`electron positron, pair production`
magnetic field, external field	`magnetic field, external field`
magnetic field, high	`magnetic field, high`
photon, dispersion relations	
field equations, solution	
threshold, pair production	`threshold`
kinematics	
photon, polarization	
vacuum polarization, ($\to$)	
magnetic field	
photon, width	
photon $\to$ positron electron	
	`electromagnetic field`
	`(0) photon, energy loss`
	`numerical calculations`

A.5 hep-ph/0112171

Title: Neutrino superbeam and factory tests of grand unified model predictions for the large mixing angle and LOW solar neutrino solutions

Abstract

Within the framework of an SO(10) GUT model that can accommodate both the LMA and LOW solar neutrino mixing solutions by appropriate choice of the right-handed Majorana matrix elements, we present explicit predictions for the neutrino oscillation parameters Δm^2_{21}, $\sin^2 2\theta_{12}$, $\sin^2 2\theta_{23}$, $\sin^2 2\theta_{13}$, and δ_{CP}. Given the observed near maximality of the atmospheric mixing, the model favors the LMA solution and predicts that δ_{CP} is small. The suitability of Neutrino Superbeams and Neutrino Factories for precision tests of the two model versions is discussed.

AUTEX Report:	SPIRES Report:
neutrino, mixing angle	`neutrino, mixing angle`
grand unified theory, SO(10)	`grand unified theory, SO(10)`
neutrino, solar	`neutrino, solar`
neutrino, cosmic radiation	
neutrino, right-handed	
mass, Majorana	
neutrino, oscillation	
neutrino, mass difference	`neutrino, mass difference`
MSW effect	
violation, CP	
numerical calculations, interpretation of experiments	`numerical calculations,`
	`neutrino, beam`
	`neutrino, particle source`

A.6 hep-ph/9910476

Title: Neutrino Oscillations in Electromagnetic Fields

Abstract

Oscillations of neutrinos $\nu_L \leftrightarrow \nu_R$ in presence of an arbitrary electromagnetic field are considered. We introduce the Hamiltonian for the neutrino spin evolution equation that accounts for possible effects of interaction of neutrino magnetic μ and electric ϵ dipole moments with the transversal (in respect to the neutrino momentum) and also the longitudinal components of electromagnetic field. Using this Hamiltonian we predict the new types of resonances in the neutrino oscillations $\nu_L \leftrightarrow \nu_R$ in the presence of the field of an electromagnetic wave and in combination of an electromagnetic wave and constant magnetic field. The possible influence of the longitudinal magnetic field on neutrino oscillations is emphasized.

AUTEX Report:	SPIRES Report:
neutrino, oscillation	`neutrino, oscillation`
neutrino, left-handed	
neutrino, right-handed	
electromagnetic field, external field	`electromagnetic field`
electromagnetic field, longitudinal	
electromagnetic field, transversal	
magnetic field, longitudinal	
neutrino, momentum	
neutrino, spin	`neutrino, spin`
effective Hamiltonian	
neutrino, magnetic moment	`neutrino, magnetic moment`
neutrino, electric moment	
moment, dipole	
resonance	

A.7 hep-ph/9812408

Title: Field-induced axion decay $a \to e^+e^-$ via plasmon

Abstract

The axion decay $a \to e^+e^-$ via a plasmon is investigated in an external magnetic field. The results we have obtained demonstrate a strong catalyzing influence of the field as the axion lifetime in the magnetic field of order 10^{15} G and at temperature of order 10 MeV is reduced to 10^4 sec.

AUTEX Report:	SPIRES Report:
axion, leptonic decay	`axion, leptonic decay`
electron, pair production	
magnetic field, external field	`magnetic field, external field`
yield, enhancement	
plasmon, propagator	
axion, dispersion relations	`dispersion relations`
plasmon, dispersion relations	
plasmon, longitudinal	
axion, lifetime	`axion, lifetime`
temperature	
numerical calculations	`numerical calculations`
Feynman graph	
axion $\to$ positron electron	
coupling, (axion photon)	
	`plasma`

Note, that the keychain *"coupling, (axion photon)"* is not present in the AUTEX Report, but it will be included in the next stage of the system development.

A.8 hep-ph/9710219

Title: Neutrino transitions $\nu \to \nu\gamma$, $\nu \to \nu e^+e^-$ in a strong magnetic field as a possible origin of cosmological γ-burst

Abstract

The high energy neutrino transitions with the photon and electron-positron pair creation in a strong magnetic field in the framework of the Standard Model are investigated. The process probabilities and the mean values of the neutrino energy and momentum loss are presented. The asymmetry of outgoing neutrinos, as a possible source of sufficient recoil "kick" velocity of a remnant and the emission of e^+e^--pairs and γ-quanta in a "polar cap" region of a remnant, as a possible origin of cosmological γ-burst are discussed.

AUTEX Report:	SPIRES Report:
neutrino, transition	
neutrino, radiative decay	`neutrino, radiative decay`
neutrino, leptonic decay	`neutrino, leptonic decay`
electron, pair production	`lepton, pair production`
flavor, conservation law	
neutrino, relativistic	
magnetic field, high	`magnetic field, external field`
electroweak interaction	`electroweak interaction`
neutrino, energy loss	`neutrino, energy loss`
neutrino, energy-momentum	
neutrino, emission	
neutrino, momentum	
momentum, asymmetry	
astrophysics, supernova	`astrophysics, supernova`
n, matter	`n, matter`
parity, violation	
pulsar, velocity	
gamma ray burst	`photon, cosmic radiation`
numerical calculations	
neutrino → neutrino photon	`neutrino → neutrino photon`
neutrino → positron electron neutrino	`neutrino → positron electron neutrino`
	`(0) neutrino, massive`

A.9 hep-ph/9404289

Title: The Radiative decay of a high-energy neutrino in the Coulomb field of a nucleus

Abstract

In the framework of the Standard Model with lepton mixing the radiative decay $\nu_i \to \nu_j \gamma$ of a neutrino of high ($E_\nu \sim 100\,GeV$) and super-high ($E_\nu \geq 1\,TeV$) energy is investigated in the Coulomb field of a nucleus. Estimates of the decay probability and "decay cross-section" for neutrinos of these energies in the electric field of a nucleus permit one to discuss the general possibility of carrying out a neutrino experiment, subject to the condition of availability in the future of a beam of neutrinos of these high energies. Such an experiment could give unique information on mixing angles in the lepton sector of the Standard Model which would be independent of the specific neutrino masses if only the threshold factor $(1 - m_j^4/m_i^4)$ was not close to zero.

AUTEX Report:	SPIRES Report:
neutrino, radiative decay	`neutrino, radiative decay`
flavor, violation	
neutrino, relativistic	
neutrino, massive	
external field, Coulomb	
nucleus, electric field	`nucleus, electric field`
electroweak interaction	`electroweak interaction`
lepton, interference	`lepton, interference`
lepton, mixing angle	`lepton, mixing angle`
mass, threshold	
neutrino, beam	
cross section, decay	`cross section, decay`
neutrino $\to$ neutrino photon	

A.10 astro-ph/9812366

Title: Neutrino emission due to Cooper pairing of nucleons in cooling neutron stars

Abstract

The neutrino energy emission rate due to formation of Cooper pairs of neutrons and protons in the superfluid cores of neutron stars is studied. The cases of singlet-state pairing with isotropic superfluid gap and triplet-state pairing with anisotropic gap are analysed. The neutrino emission due to the singlet-state pairing of protons is found to be greatly suppressed with respect to the cases of singlet- or triplet-state pairings of neutrons. The neutrino emission due to pairing of neutrons is shown to be very important in the superfluid neutron–star cores with the standard neutrino luminosity and with the luminosity enhanced by the direct Urca process. It can greatly accelerate both, standard and enhanced, cooling of neutron stars with superfluid cores. This enables one to interpret the data on surface temperatures of six neutron stars, obtained by fitting the observed spectra with the hydrogen atmosphere models, by the standard cooling with moderate nucleon superfluidity.

AUTEX Report:	SPIRES Report:
neutrino, energy	
neutrino, emission	`neutrino, emission`
astrophysics	`astrophysics, model`
n, matter	`n, matter`
n, pair	
p, pair	
pair, Cooper	
nucleon, superfluid	`superfluid`
superfluid, gap	
anisotropy	
neutrino, luminosity	`neutrino, luminosity`
Urca process	
star, energy loss	
temperature, surface	
critical phenomena, temperature	
redshift	
temperature, dependence	`temperature, dependence`
bremsstrahlung	
numerical calculations	`numerical calculations, interpretation of experiments`