THESIS ABSTRACT

学 位 论 文 摘 要 汇 编

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高能物理研究所学位委员会

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目　　录

τ 轻子寿命测量

姓 名: 杨长根

导 师: 唐孝威

学 位: 博 士

摘 要

到目前为止，关于弱电相互作用的标准模型已经被广泛接受，但是对其普适性假定进行检验的实验还进行的不够。

本文对 L3 探测器上 1991 年收集的 $Z0 \to \tau^+\tau^-$ 事例进行了 τ 寿命的测量。用了两种方法提高对寿命测量起关键作用的 TEC(Time Expansion Chamber) 的 DCA(Distance of Closest Approach)分辨，一种是利用电子和 μ 子精确的能量和动量测量，确定 TEC 测量径迹的曲率半径，对径迹参数进行重新拟合。另一种是对 TEC 每半个单元的DCA 平均漂零偏移进行校准。这两种方法相结合量出 TEC 对μ子的DCA 分辨为 59μm 。

利用现有的 L3 程序和μ子事例对 1991 年每次加速器束团注入中心位置进行了计算。由DCA 宽度随 φ 角分布测量的束团大小在横向为 169μm，纵向为 12μm，与 LEP 预期的束团大小相符。这个尺寸包括了束团在一次注入中束团平均位置移动的误差，在 τ 寿命测量中对这个误差不再另行考虑。

经过事例选择，我们共得到 1855 个τ 衰变到轻子道的事例，3372 个 τ 衰变到一个带电强子道的事例，516 个 τ 衰变到三个带电强子道的事例。

对衰变末态为一个带电径迹的 τ 事例用 Impact Parameter(I. P.)的方法进行 τ 寿命拟合。对其中轻子末态经带电径迹因探测重新拟合后，DCA 分辨好，进行单独拟合。对轻子和强子的I. P. 分布，首次把 I. P. 变负的可能性放入到拟合公式中进行拟合。对末态为三个带电粒子的 τ 衰变用衰变长度的方法进行拟合，衰变长度的拟合中考虑了束团大小、衰变顶点和衰变方向间的相关联性。

τ 寿命测量的系统误差主要来源于 TEC 的漂移速度和零时间测量，为10fs，总

的系统误差为12fs。三种衰变末态τ寿命测量结果的加权平均为：293±9(统计误差)±12(系统误差)fs。由此计算的$(G_\tau/G_\mu)^2=0.998\pm0.050$，与标准模型的轻子普适性假定相符。

Tau Lepton Lifetime Measurement

Name: Yang Changgen
Supervisor: Tang Xiaowei
Degree: Doctor

ABSTRACT

The Standard Model is currently consistent with all experimental tests and is generally accepted as giving the correct description of electroweak interactions, although the fundamental assumption of universality is not yet well tested.

This thesis deals with the measurement of the mean tau lifetime from data taken by L3 in 1991.

To measure tau lifetime precisely, the DCA (Distance of Closest Approach) resolution of tracks from TEC (Time Expansion Chamber) is crucial. Two methods are used to improve this resolution. First, the momenta of electrons and muons are measured with high precision by BGO calorimeter and muon chambers outside TEC, one can fix the curvature to the corresponding value and obtain a better DCA measurement. This is only applicable to lepton tracks. Second, offsets of the DCA average value measured in Bhabha and di-muon events can be used to correct for residual shifts in each half-sector after calibration. This correction can be applied to all tracks. Combining momentum constraint method and the half-sector shift correction, the TEC track resolution has been improved from 137μm to 59μm for 45GeV momentum tracks.

We use the good quality tracks from hadronic events and existed L3 routines to determine the position of fill vertices. The beam position was

stable in 1991. The beam spot size is determined with the DCA resolution from Bhabha and di−muon events by calculating the width of the DCA distribution at different phi angle. With known TEC resolution of 59μm, we deduce a beam spot size of 169μm in horizontal direction and 12 μm in vertical direction which in good agreement with the range of values expected from the LEP beam optics. The size we obtaind contains the error on the average of beam position of each fill, which thus does not have to be taken into account seperately.

An impact parameter method is used for one prong decays, the leptonic tau decays are treated seperately, since their tracks can be refitted with precise momentum measurement. The decay length method is used for three prong decays. We end up with 1855 one prong leptonic tau decays, 3372 one prong hadronic tau decays and 516 three prong tau decays.

After applying both the constraint refit and half−sector shift correction for the leptonic decays and only half−sector shift correction for the hadronic decays, a binned maximum likelihood fit has been used to fit the impact parameter distribution. The sign−flip probability has first time been used to measure the changement of the sign of impact parameter.

For three prong decays, the decay length is measured from the position of beam spot to the vertex fitted from the three tracks of tau decays, taking into account the covariance matrices of both vertices and the direction of the tau as approximated by the thrust axis.

The main source of systematic error for the tau lifetime measurement are the systematic error of 10fs from the TEC calibration, the total of the systematic error for the combined lifetime measurements is 12fs.

The combined result of tau lifetime from all three samples is: 293 ± 9 (stat.) ± 12(sys.)fs. This result yields $(G_\tau/G_\mu)^2 = 0.998 \pm 0.050$, consistent with the hypo−thesis of lepton universality.

束流相空间非线性传输及其专家系统

姓　名：夏佳文
导　师：魏宝文
学　位：博　士

摘　　要

束流相空间非线性传输理论在本论文中得到了佳文。在此理论中，鲑子束是一个非魏佳动力学系统，而非线性动力学系佳相空间传输是指系统相空间的形状由初态 X0＝X(t0)到末态 Xt＝X(t)的变化，即由系佳初态相空间边界方程 F(X0)＝0，变佳到系统末态相空间边界方程 F[X0(Xt, t)]＝f(Xt, t)＝0。此过程是非魏性的。现完成了普遍的非鲑性动力学系佳相空间运动微分方程任意阶解析博的鲑变魏，首次在理论上实现了非线佳动力学系魏相空间的非线佳传输，在国际上尚未有类似的鲑导。鲑实际相空间的传佳，如加速器束魏博器，电子光学，集成电路曝光等提供了非魏佳的鲑学统型。在建立速个相型时，还构造了一个人工智提专家系统。一个用智佳语言 Arity/Prolog 编写的逻辑程序在 IBM－PC 机上运行而形成的专家系统，可以自动推导且输出任意阶非鲑佳指输系鲑普统表达式。应用此现输，鲑出了具体的加速器束流相空间二阶指输实佳。并在此基础上，作了实际非鲑性传统的初步探束。

最后，应用非魏性传输理论的一语近似形式对 HIRFL 的两个工程题目：HIRFL 剥离膜后切束魏及 SFC 引出磁束速，进行了束魏博统鲑器理鲑计和统术设计。在一定程应上统高了 HIRFL 鲑运行鲑率和佳用价佳。相空间非线佳传输理论是一个普遍输理论，不但对加速器系鲑，也对许多领域的非魏性系魏，有着束要的应用束义。

Nonlinear transport theory of beam phase space and its Expert System

Name: Xia Jiawen

Supervisor: Wei Baowen

Degree: Doctor

ABSTRACT

A new nonlinear transport theory of beam phase space was established inthis thesis. In this theory, accelerator beam is a nonlinear dynamic system, and its phase space transport means the deformation of the phase space shape from the initial state $x_0 = X(t_0)$ to the final statex $X_t = X(t)$. mathematically, this deformation is the transform from the initial boundary equation of phase space $F(x_0) = 0$ to the final one $- F[x_0(x_t, t)] = f(x_t, t) = 0$. This transform is nonlinear. Now, the inverse transform of the any order analytical solution of the nonlinear dynamical differential equation was developed in this thesis, and the function relation $x(t_0) = x_0(x_0\ t)$ was obtained, thus for the first time realizing theoretically the nonlinear transport for the phase space of nonlinear dynamical system, and a mathematical model was provided for the practical nonlinear beam transport, such as in accelerators, electronmicroscopes, lithographs etc. In the process of establishing the model, an artificial intelligence expert system was made to derive and output automatically the general expressions of any order transport coefficients. By using the nonlinear transport theory, a concrete example of second order transport for beam phase space was work out in detail, showing vividly the evolving phase space boandary of a concrete second order nonlinear system. Finnlly, with the first order form of nonlinear transport theory, the

beam transport designs were completed for the split – beam line behind the stripper of HIRFL and the magnetic channels of SFC. port designs were completed for the split – beam line behind the stripper of HIRFL and the magnetic channels of SFC.

消融型宇宙尘埃粒子研究

姓　名：　周瑞琪

导　师：　姓英庭

学　位：　博　士

摘　　要

本学位论文论及到消融型宇宙尘球粒姓研究粒周，图像学的特征，化学成份，同位素组成和原子团簇化学动力学等五文领域。

一. 宇宙尘粒粒子研周进展

领出以下研究方向可能将是今后几年宇宙尘埃研究姓热点领域：1，宇宙尘埃形成，增生，领化的计算机动力学领领；2，宇宙尘粒纳米尺度表面结构的分数维特征与化学热动力学过领之间的相互关系；3，原始太阳星云尘域原子图姓的化学动力学和极早期星云凝聚历史；4，消融宇宙尘的大气消维过程与同位素分周；5，深海宇宙尘与火山微球粒的成因标志；6，新技术，新方法在宇宙尘埃研究领域中的广泛应用。

二. 深太平洋底微球粒表面结构和图像学

观测了40颗深太平洋和文古代变质岩中微球粒的表面结构特征，并与两领陕西第四系黄土中的生物球粒的内、外表面图像学特征进行了对比。

透射电领和电子衍射的研究表明无论是消融宇宙尘还是火山球粒，都可见到无序的粒璃结将与有序的域晶结将混生的璃象，表明它们都经历了快姓冷凝的过领。

运用扫领周度显微镜(STM)周测了一凝深周像质宇宙尘球粒(M0－6)姓亚深米和姓米结构，并与一块宁姓(IVA)快陨石的粒切领特片的表面结特姓行了对比。

三. 深博宇宙尘元维粒成和分布

用EDS和EPM领度了三十颗深博微球粒，两领太古代弓长岭火山变领岩中快质球微和两镜博四系黄土中生特球粒的主变元素丰度，并与已发表的周融宇宙尘和粒地火山球的主元素姓凝进行了广泛对比。

四. 深博宇宙尘的领同位素组成

建立了小颗粒样品 M g 同位素分析的实验和误差分析方法，并测量了 15 颗深海宇宙尘和 10 块不同陨石样品的 M g 同位素组成，发现铁质和玻璃质宇宙尘与铁陨石处于同一 M g 同位素分馏线上，而石质宇宙尘的 M g 同位素组成有较大的变化，但大体与球粒陨石分布区相近。初步分析和讨论了大气消融对宇宙尘球粒 M g 同位素组成的影响，认为蒸发过程是导致 M g 的轻同位素相对亏损的原因。深海铁质宇宙尘的 M g 同位素测试结果支持了铁质宇宙尘属于铁陨石大气消融产物的看法，两颗玻璃质宇宙尘的镁同位素分布则表明它们也可能与铁陨石的大气消融的蒸发残余相有关。

五、太阳原始星云原子团簇的初步研究

本文从 Fe: Mg: Si: O = 1: 1: 1: 4 的早期太阳星云中原子的两体碰撞几率开始，对均匀随机状态下某一特定团簇的碰撞几率和有效碰撞数的表达式进行了计算和讨论。给出，K 粒子原中任一特定团簇的碰撞几率，并给出了太阳星云原子团簇的统计热力学的定态模型。

Research on the Ablated Cosmic Dust

Name: Zhou Yaoqi
Supervisor: Xu Yinting
Degree: Doctor

ABSTRACT

Five research fields of the ablated cosmic dust, such as review, morphology, chemical composition, isotopic distribution and atomic cluster, have been discussed in this thesis.

1.A Review on the Research of Cosmic Dust

Almost 200 papers and confereuce abstracts about the research of cosmic dust since 1985 have been reviewed in detail. The history and present situation of the cosmic dust research on the clussfication, methods, hypotheses of the formation are reviewed and prospected iu this paper. It is discussed in emphasis that the physical structure, mineral, chemical composition, and isotopic distribution of the IDPs and deep−sea cosmic dust, and the relationship with their various sources.

It is pointed out that the following aspects of the research would be the hot fields of the cosmic dust research in the following years:

. The computer dynamics simulation of the formation, accretion, and evolution of cosmic dust;

. The relationship between the fractal features of the nanometer surface structure of the cosmic dust and the process of the chemical thermodynamics;

. The chemical thermodynamics of the atomic clusters in the early solar nebular and the condensation history of the nebular;

. The isotopic fractionation and the ablation process of the cosmic dust in atmospheric entry;

. The distinguished mark between the ablated cosmic spherules and volcanic spherules in deep sea;

. A wide application of new techniques and methods in the research fields of cosmic dust.

2.On the Morphology of the Deep – Sea Microspherules

The morphological features of 40 microspherules in deep sea, metamorphic rocks of Archaean group, and Xian locss of Quaternary have been observed and determed by optical microscope, SEM and TEM. It is discovered that the morphologicel classes can not reflect completely the original ones, and it is very difficult to distinguish the ablated cosmic spherules from the volcanic microspherules only depending on their morphological features.

From the results of TEM and ED research, we can see the mixing phenomenon between the chaotic glass and orderly crystal in all the microspherules not only the ablated cosmic dust but also the volcanic spherules, which imply their fast condensation experience.

Observation of the submicron – nanometer structure for one deep – sea iron cosmic sphere (M0 – 6) and comparision with that of a laser – cut fragment of Ninbo iron meteorite have been done with scanning tunneling microscopy (STM). Through quantitative calculation of fractal geometry, the self – similarity morphological features in the submicron range have been found on the surface of both the iron cosmic sphere and the laser – cut fragment of iron meteorite. However, their fractal features are very different, the D value of the former is about 2.3, and that of the latter is 2.6 to 2.7.

The surface structure in nanometer range is relatively gently for both the ablation iron cosmic sphere and the laser – cut fragment of iron meteorite. However, the former sometimes has island – distributed grain or cluster structure (0.5 to 1.5nm in scale), the latter shows the fuzzy cluster structure in less 20nm range, in which the differentiation of the atomic structure is lower.

3.Abundance and Distribution of the Major Elements in Deep－Sea

The major element abundances of 30 deep－sea microspherules, 4 iron volcanic spherules from the Gongchangling metemorphic rocks of Archaean group and 2 organical microspherules in Xian loess of Quaternary have been determined with the X－ray Energy Diffraction Spectrometer (EDS) and Electron Probe Microanalyzer (EPM). A large amount of the public major element data of microspherules is also used in this paper. In Si－Mg－Fe atom composition, almost all 30 data of 24 deep－sea ablation cosmic dust spherules are distributing along the line from Fe tip to the middle of Si－Mg tips. The ablated cosmic dusts have lower abundances of Si and Mg, and higher abundance of Fe in comparision with the non－ablated stratosphere IDPs., the locations of silicate cosmic spherules close the centre of the figure of Si－Mg－Fe atom composition, and most of the data of iron cosmic spherules clearly gather to the Fe tip. The distribution between I－spherules and S－spherules is gradually transitional, which may imply they are correlated in origin.

The distribution of volcanic microspherules in Si－Mg－Fe atom composition. From this figure, most of the volcanic microspherules can be divided clearly from the cosmic dust spherules. Generally, almost all volcanic microspherules distribute along the Fe－Si line, the relative abundance of Mg is less than 20 w.t.%, and generally less than 10 w.t.%. In spite of this, for the iron volcanic spherules, it is difficult to distinguish from the iron cosmic spherules in Si－Mg－Fe atom composition. However, the iron cosmic spherules have a little Ni, and the iron volcanic spherules have some K, Na, Cl, and S, which may be as the distinguished foundation for the iron microspherules. But for the iron microspherules without above elements whos abundances can be determined with the EPM, their distinguished foundation must depend on the trace elements.

The trace elements of 11 deep-sea microspherules have been measured with INAA, and the public trace element data of a number of microspherules in deep sea, strata, and shallow sediments of South Sea are also for reference in this paper. Despite the difference of Fe and Ca abundances, the range of the trace element abundances of deep-sea silicate cosmic spherules are almost the same as that of the iron cosmic spherules. However, in the matter of the whole, the siderophile element abundauces of iron cosmic spherules are a little higher than that of silicate cosmic spherules.

The glass cosmic spherules have a higher richment of Os, Ir and REE, and a loss of Fe, Co, Ni, Cr, Na, K, and Au in comparison with CI chondrite. Comparied with deep-sea cosmic spherules, the volcanic spherules have a clear richment of chalcophile elements As, Br, and Sb, lithophile elements Cs and K, and have a relative loss of siderophile elements Os, Ir, Au, Fe, Co and Ni, and lithophile Sc. But in the abundance change ranges of Na, Ca, REE, Cr and W, there are not differences between the volcanic and cosmic spherules.

4.The Composition of Mg Isotope in the Deep-Sea Cosmic Dust

Using the Ion Mass Spectrometer (ST-IMS) made by Synton Corporation, we have developed an experimental method and an error analysis system to determin the Mg isotope composition of microsamples. The Mg isotope compositions of 15 deep-sea cosmic spherules and 10 different meteorite samples are measured in this paper. From this figure we can see that the iron, glass microspherule and iron meteorites distribute along the same fractionation line, while silicate microspherules turn away from the fractionation line and close the distribution range of chontrites. This obviously shows that I-spherules and G-spherules are the atmosphere ablation products of iron meterites, while S-spherules may have very complex Mg isotope fractionnation process or different origins. The high-temperature evaporation in the ablation process is thought to be one of the importan' way leading to the dynamic fractionation of Mg isotope.

5.An Approach of the Atomic Clusters in the Premitive Solar Nebula

The formation and distribution of Si－O, Fe－O, and Mg－O atomic clusters at a high energy environment of primitive solar nebula were studied by means of a simulation experiment of the laser ablation on two CV3 chondrites (Allende and Ningqiang). A Time－of－Flight Mass Spectrometer (TOFMS) was used in the simulation experiment.

The comprehesive explanation results of the TOFMS of some main atomic clusters produced in the simulation experiments with Allende and Ningqiang are the peaks with messes of 148, 164, 180, 200, 204, 220, 228, 248 and 264 a. m. u. are clear. They are mainly the atomic clusters of Si－O and Fe－O. Among all these atomic clusters, Si3O4, Si3O6 and Fe3O2 clusters are the relatively most stable ones.

Starting from the two－body collision frequency of the atoms in primitive solar nebula where the Fe: Mg: Si: O is 1: 1: 1: 4, this paper discussed and calculated the probability of collision and the formula of effective collision number. The collision probability of a certain cluster (PK which consist of K atoms can be got. The statistical thermodynamics steady model has be given.