**Физика. Текст 1.**

**Low-Energy Electron Scattering by CS2 Molecules**

*Mбrcio H. F. Bettega*

Departamento de Fнsica, Universidade Federal do Paranб,

Caixa Postal 19044, 81531-990, Curitiba, Paranб, Brazil.

*Abstract*

We report the integral elastic cross section for low-energy electron scattering by CS2 molecules.

To perform our calculations we used the Schwinger multichannel method with pseudopotentials.We

have found, in a static-exchange calculation, a shape resonance around 1 eV that belongs to the *\_u*

symmetry.With the inclusion of polarisation effects only in that symmetry, we show that the resonance

becomes a bound state. This result is in agreement with other results available in the literature.

Scattering of low-energy electrons by CS2 has been the subject of recent theoretical and

experimental studies. Lee *et al.* (1999*a*) calculated elastic differential, integral and grand

total (elastic+inelastic) cross sections by means of the Schwinger iterative method combined

with the distorted-wave approximation. To describe the e−–molecule interaction they

used a complex potential consisting of static, exchange, correlation-polarisation and absorption

terms, obtained from a fully molecular wave function. Bettega *et al.* (2000*a*) calculated

elastic integral, differential and momentum transfer cross sections for energies from 5 to

50 eV, using the Schwinger multichannel (SMC) method with pseudopotentials (SMCPP).

Sakamoto *et al.* (1999) measured elastic differential cross sections at selected energies.

There are also the experimental studies of Szmytkowski (1987) and Sohn *et al.* (1987) and

the calculations of Lynch and Dill (1979) and Raj and Tomar (1997). Lynch and Dill used in

their calculations the continuum multiple-scattering model (CMSM), along with the Hara

potential for the exchange interaction, to study elastic scattering of electrons by CO2, OCS

and CS2. They found a relative insensitivity of their results to the polarisation potential,

but they did not report whether they included the polarisation interaction in their e−–CS2

scattering calculations, in order to check the insensitivity of this particular molecule to this

interaction. They chose to present their results for these molecules without including polarisation.

In particular, the CS2 cross section of Lynch and Dill shows a low-energy shape

resonance around 2 eV, associated with the *\_u* symmetry. However, there is no indication

of such a resonance in the theoretical results of Lee *et al.* which take polarisation effects

into account, or in the experimental data of Szmytkowski and Sohn *et al.*. In our previous

study on e−–CS2 collisions we have avoided energies lower than 5 eV, and therefore we

were not able to investigate the existence of this low-energy resonance.

**Физика. Текст 2.**

**Preparation of Motion Entangled Coherent States**

**of Two Cavity Mirrors**

*Shi-Biao Zheng*

Department of Electronic Science and Applied Physics,

Fuzhou University, Fuzhou 350 002, P. R. China.

email: sbzheng@pub5.fz.fj.cn

*Abstract*

Ascheme is proposed for the generation of entangled coherent states of two spatially separated cavity

mirrors. In the scheme, a two-level atom is sent through two cavities, each having a movable mirror,

to produce an entangled photon state for the cavity fields. Then the optomechanical effects further

entangle the mirror motions with the cavity fields. A second two-level atom, passing through the

cavities, is state-selectively measured, which reduces the mirror motions to an entangled coherent

state.We also show how to distinguish such an entangled state from a classical mixture.

**1. Introduction**

Over the past few years, much effort has been directed to the so-called Schrцdinger cat

states (Schrцdinger 1935), i.e. superpositions of macroscopically distinguishable quantum

states. In quantum optics these states are usually given as superpositions of two coherent

states |*α*\_ and |−*α*\_, which are separated in phase by *π*. Though formed by quantum

states closest to the classical ones, such superposition states may exhibit various nonclassical

properties, such as squeezing and sub-Poissonian statistics (Janszky *et al.* 1993,

1995; Janszky and Vinogradov 1990; Xia and Guo 1989). Recently, such cat states have

been realised for both a cavity field (Brune *et al.* 1996) and the motion of a trapped ion

(Monroe *et al.* 1996).

In a recent paper, Mancini *et al.* (1997) have shown that a cavity with a movable mirror

can also be used to produce Schrцdinger cat states of the cavity field. More recently, Bose

*et al.* (1997) have shown that such a system can lead to a large variety of nonclassical

states of the cavity field. Moreover, it is shown that the mirror can also be prepared in a

Schrцdinger cat state with many components by a quadrature measurement of the cavity

field after its interaction with the moving mirror. The idea of Bose *et al.* (1997) offers a

way to generate nonclassical states for a macroscopic object. Recently, we have proposed

a scheme to put the mirror into the even or odd coherent states (Zheng 1998).

On the other hand, there have been multi-mode generalisations of the cat states, which

are called entangled coherent states (Sanders 1992*a*, 1992*b*), also referred to as superpositions

of two-mode coherent states (Chai 1992; Ansari and Man’ko 1994; Dodonov

*et al.* 1995). These superposition states may exhibit various nonclassical properties, such

as two-mode squeezing and violation of the Cauchy–Schwarz inequality. It has been shown

that, under certain conditions, superpositions of two-mode coherent states can exhibit

various nonclassical features such as sub-Poissonian photon number statistics, two-mode

squeezing, and violations of the Cauchy–Schwarz inequalities (Chai 1992).

**Физика. Текст 3.**

**Generation of Multicavity Entangled States**

**with a Single Three-Level Atom**

*Shi-Biao Zheng*

Department of Electronic Science and Applied Physics,

Fuzhou University, Fuzhou 350 002, P. R. China.

email: sbzheng@pub5.fz.fj.cn

*Abstract*

A simple scheme is proposed for the generation of maximally entangled states for several separated

cavities, in which each cavity is in a one-photon state or in the vacuum state. In the scheme a laddertype

three-level atom is sent through the cavities and additional classical fields. The whole system

finally evolves into a state, which is given by the product of the highly entangled field state with an

atomic state.

In recent years much attention has been paid to entanglement, which is one of the most

striking features of quantum mechanics. The correlation between two systems can be used

to test local hidden variable theories against quantum mechanics (Bell 1967). Maximally

entangled states of three or more systems, referred to as Greenberger–Horne–Zeilinger

(GHZ) states (Greenberger *et al.* 1989, 1990) allow a stronger test of local hidden variable

theories without using Bell’s inequalities. Besides the investigation of fundamental aspects

of quantum mechanics, entangled states are useful in fields involving quantum information,

such as quantum cryptography (Ekert 1991), quantum computation (Deutsch and Jozsa

1992), and quantum teleportation (Bennett *et al.* 1993).

Ascheme, based on the resonant atom–field interaction, has been proposed for preparing

two two-level atoms in a maximally entangled state (Cirac and Zoller 1994; Kudryavtsev and

Knight 1993; Phoenix and Barnett 1993). Recently, such a scheme has been experimentally

realised (Hagley *et al.* 1997). It has also been shown that a GHZ state of three atoms can

be generated using the resonant atom–field interaction if the field is initially prepared in a

superposition of a three-photon state and the vacuum state (Cirac and Zoller 1994). Other

cavity QED methods (Gerry 1996*a*, 1996*b*; Zheng 1998, 1999) have also been proposed for

the preparation of multi-atom GHZ states. In a very recent paper, Sackett *et al.* (2000) have

reported experimental entanglement of four trapped ions using a new technique proposed.

On the other hand, three-photon GHZ entanglement has also been observed (Bouwmeester

*et al.* 1999; Pan *et al.* 2000).

Proposals have been suggested to entangle spatially separated cavities. As an intermediate

step of teleportation, Davidovich *et al.* (1994) have shown how to produce two-cavity

entangled states, in which a single photon resides in either cavity. Using a combination of

quantum switches Davidovich *et al.* (1993) have proposed a scheme for the generation of

the entangled coherent states (Sanders 1992*a*, 1992*b*) for two cavities. Kim and Lee (2000)

have suggested a nonlocal test for entangled states of two spatially separated cavities.

**Физика. Текст 4.**

**Positron Lifetimes and Microhardness in**

**Thermal Fatigued 4Cr5MoSiV Steel**

*C. Q. Tang,*A *Z. C. Xia,*A *X. Z. Li*B *and B. T. Yao*B

A Department of Physics, Huazhong University of Science and Technology,

Wuhan 430 074, People’s Republic of China.

B Department of Materials Science, Huazhong University of Science and Technology,

Wuhan 430 074, People’s Republic of China.

*Abstract*

Positron lifetimes and microhardness have been measured as a function of the thermal fatigue cycle

number *N* in 4Cr5MoSiV steel. It is found that with increasing *N*: (a) the positron lifetime parameters

*τ*1*, τ*2*, I*1*, I*2 and *τ* and the microhardness parameter MH all exhibit quasi-periodic up-and-down

variation; (b) these parameters have the same period of variation; and (c) the period of up-and-down

variation becomes gradually longer. The variation of MH reveals that fatigue hardening and fatigue

softening occur alternately in the process of thermal fatigue. The variations of positron lifetime

parameters reveal variations of defects in the fatigued materials. These variations are attributed to

microdeformation and dynamic recovery dominating alternately in the process of thermal fatigue.

**1. Introduction**

It is well known that positron annihilation lifetime spectroscopy (PALS) is a useful tool

for studying lattice defects in metals and alloys (Hautojarvi 1979; Brandt and Dupasquier

1983). PALS has been widely used to study variations of structure and defects induced due to

quenching, deformation, fatigue, radiation etc. in many metals and alloys. Due to the complexity

of data interpretation most of the earlier positron annihilation studies on defects were

limited to simple metals and alloys rather than complex polycrystalline materials. However,

probing defects and their variations in a complex material and/or in a material undergoing

a complex treatment process is a more attractive subject and is also challenging to PALS.

Thermal fatigue is an important phenomenon for a heat-worked die material. In the

process of thermal fatigue, the die material undergoes periodic heating and cooling, and so

is damaged to different degrees. Usually, the fatigue damage is evaluated by observing crack

networks at the surface of the fatigued material; however, these crack networks reflect only

surface damage and cannot reveal interior damage information of the fatigued sample. Our

work on positron lifetimes in thermal fatigued die steels (Tang *et al.* 1993*a*, 1993*b*, 1993*c*)

has shown that PALS may be a useful tool for probing variation of defects in the interior

of fatigued material. However, numerous subjects such as the determination of defect type

in complex alloys, corresponding relationships between analysed positron lifetimes and

real positron lifetimes in the case of high defect-concentration, and the utility of PALS in

relation to other techniques, should be investigated further.

**Физика. Текст 5.**

**Position Indeterminacy in**

**Ortho-positronium Decay**

*Fosco Ruzzene*

PO Box 120, Clifton Hill,

Vic. 3068, Australia.

email: foscoantonio@netscape.net

*Abstract*

Position indeterminacy contributions to the decay width of ortho-positronium (o-Ps) are calculated for

lowest order. Contributions improve agreement between theory and the Ann Arbor group measurements,

while suggesting a value larger than that of the Tokyo group.

**1. Introduction**

The possibility of position indeterminacy to explain a possible discrepancy between

theory and experiment for the Lamb shift of low-lying hydrogen-like atoms is examined in

an accompanying paper (Ruzzene 2000; present issue p. 631). An approximate (*Z*)6 term

is introduced to the classic Lamb shift, giving position indeterminacy contributions of the

same magnitude as the accuracy of current QED theory and experiment.

The position indeterminacy length is given by the relation

(1)

This expression is obtained by imposing a maximal acceleration (Caianiello 1984) on the

dynamics of the uncertainty relations. Since the quantum mechanical particle position

cannot then be precisely defined, the momentum operator is a difference operator, i.e.

(2)

where*i* and p *i* are the finite and momentum difference operators respectively. Position

indeterminacy contributions are then calculated treating the second and higher order terms

in standard perturbation theory.

In this work position indeterminacy contributions to the decay width of o-Ps are calculated

to lowest order. The experimental situation for o-Ps is interesting, but ambiguous.

Measurements by two different groups are currently in disagreement. The Ann Arbor

group (Nico *et al.* 1990) gave the two values 7.0514(14)s−1and 7.0482(16)s−1for gas

and vacuum measurements respectively. A more recent measurement by the Tokyo group

gives the result of 7.0398(29)s−1(Czarnecki*et al.*1999). Clarification of this

experimental situation is reported to be in progress. The current theoretical prediction for

the lifetime is 7.039970(10)s−1Adkins*et al.*2000; Kniehl*et al.*2000). Should the Ann

Arbor results be confirmed, agreement arising from higher order QED is expected to be

most unlikely.