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Atomic parity non-conservation: Present status and future prospects

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Abstract. The general features of parity nonconservation (PNC) in atoms arising from neutral weak currents and the nuclear anapole moment are discussed. The theoretical approaches used to calculate PNC observables are briefly mentioned. A brief review of the present status of atomic PNC is presented and its potential as a probe of physics beyond the standard model is highlighted.

Keywords. Parity nonconservation; standard model; neutral weak currents; nuclear anapole moment.

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1. Introduction

The discovery of parity non-conservation in the beta decay of ^{60}Co by Wu and co-workers [1] about forty years ago marked an important landmark in the history of physics. This phenomenon which suggests the lack of mirror or left-right symmetry has now been observed in several physical systems. An important case in point is parity non-conservation in atoms [2]. Indeed parity non-conservation has now been observed in several atoms [3]. The latest measurement on caesium has yielded a result of unprecedented accuracy (0.35%) and has led to the discovery of the nuclear anapole moment [4].

It does appear that atomic parity non-conservation can serve as an important probe of physics beyond the standard model (SM) of particle physics if the present accuracy of the atomic theory is improved, or the uncertainties associated with it can be removed by comparing very accurate parity non-conservation measurements on several isotopes of the same element [5]. It has been pointed out that atomic parity non-conservation can provide significant constraints on models that suggest the possible observation of leptoquarks in the events that were recently observed at the HERA collider [6].

This article first presents the general features of parity non-conservation in atoms and then focuses on its present status and future prospects.

2. General features of parity nonconservation in atoms

The dominant contribution to parity non-conservation in atoms comes from the neutral weak current (NWC) interaction between the electrons and nucleons [7]. The effective Hamiltonian describing the interaction consists of two parts; one of which is nuclear spin