Data reduction schemes currently used for time differential perturbed angular correlation measurements are evaluated in terms of (i) their relative effectiveness in eliminating irrelevant variables, including single counter efficiencies and spectrum time shifts; and (ii) their effectiveness in putting data in a form that can easily be fitted by theoretical correlation functions. It is pointed out that erroneous conclusions may be derived from improperly reduced data, but that properly analyzed experiments performed at four angles allow a good determination of both the time-dependent and time-independent parts of the correlation function. Correction of data for accidentals, source self-absorption and spectrum livetime differences are discussed.

1. Introduction

The technique of time differential perturbed angular correlation (DPAC) of \(\gamma\)-rays has been known for more than twenty years. It became well established in nuclear laboratories about the time that multichannel analyzers could be combined with the excellent timing characteristics of scintillation counters. Most early applications involved extracting a single frequency and deriving from it a nuclear \(g\)-factor [1]. For this purpose rather simple data reduction methods were adequate, and the question whether the full theoretical \(\gamma\)-ray anisotropy was observed was of little concern.

More recently DPAC has developed as a sensitive tool in condensed matter science, with applications to a wide range of problems involving nuclear hyperfine

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interactions. In most cases one dissolves a small quantity of radioactive probe atoms into the material to be studied. Typical of these "second generation" experiments is the study of hyperfine fields and quadrupole interactions in crystalline solids [2-5]. Data reduction requirements remained rather simple.

During the last five years a "third generation" of DPAC studies has developed with the study of lattice defects trapped at DPAC probe atoms in metals. As exemplified by the work of groups in Berlin [6], Bonn [7], Groningen [8], Konstanz [9], and Orsay [10], these experiments may involve three or four distinctive populations of nuclei, each in a different defect configuration, and each having different magnetic, electric quadrupole or combined interactions. To characterize these populations fully it is necessary to measure the amplitude of each signal absolutely, including time-independent and slowly varying precessional components, and to sum the various amplitudes to obtain the full theoretical anisotropy. This requires a degree of care in data collection and analysis that, while already achieved in some laboratories, is probably not appreciated by the wider community at work on the application of DPAC.

Fig. 1. Two alternative block diagrams for doing perturbed angular correlation experiments. The system on the left involves gating of fast timing pulses by the corresponding energy spectrum. It has the advantage of low time-to-amplitude converter count rates, but requires the insertion of a large delay into the fast discriminator line. The system on the right involves gating of the multichannel analyzer by slow coincidence pulses related to the appropriate energy spectra. It has the advantage of avoiding long delays in the fast discriminator line, but produces high count rate in the time-to-amplitude converter.