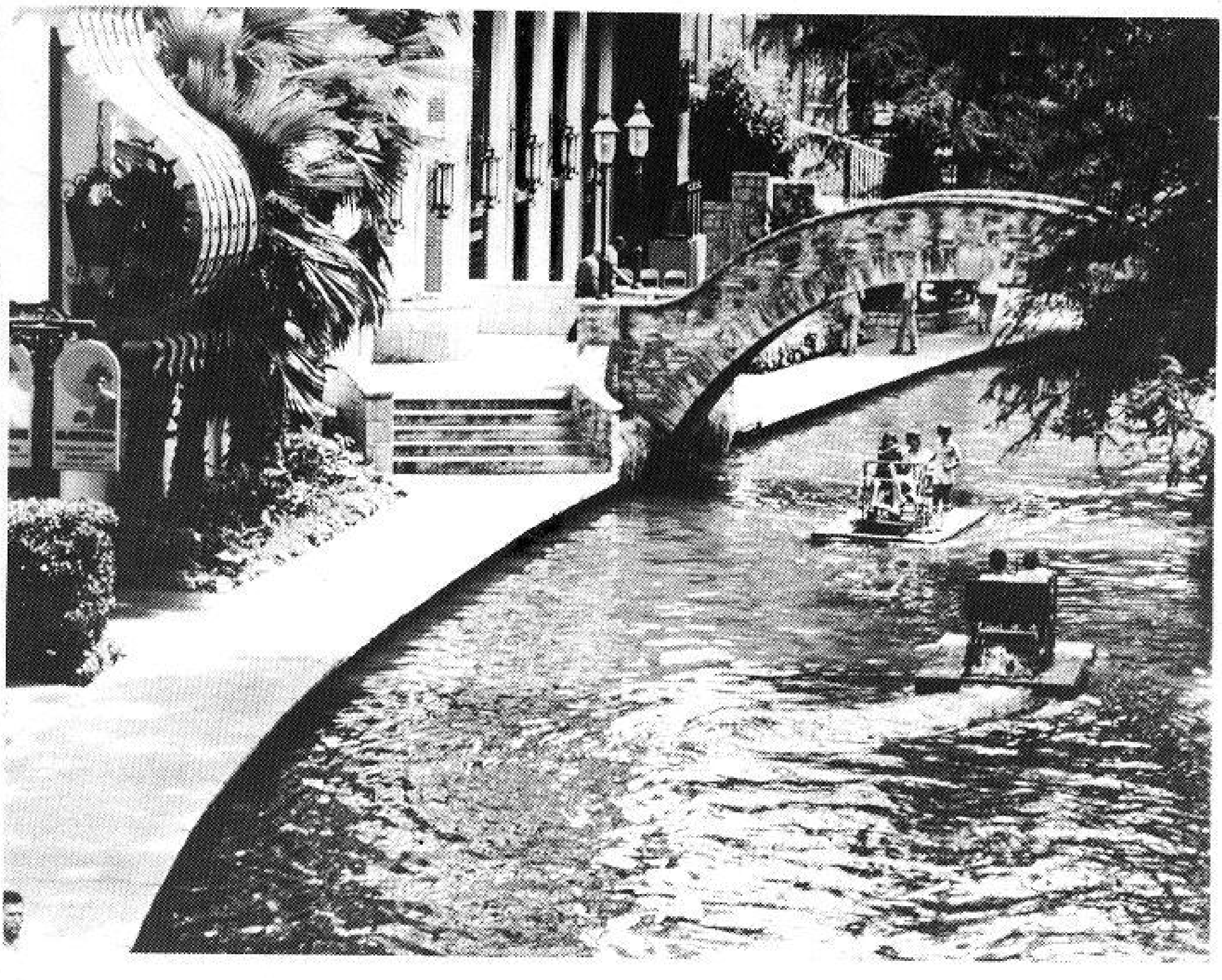
AAPT ANNOUNCER

December, 1983
Vol. 13, No. 4

Annual Joint APS/AAPT Meeting
30 January - 2 February 1984
San Antonio, Texas



SESSION AF: NON-LINEAR OPTICS, LASERS, MISCELLANEOUS MOLECULAR EFFECTS

Monday morning, 30 January 1984
Room 33 at 9:00
C. E. Hathaway, presiding

9:00

AF 1 Experimental Study of the Variation in the Quality of Real Image Reconstruction of Objects Via S·R·S and S·B·S. SWATI ROY and R. J. LYSIAK, Texas Christian U.--Metallic grids having different spacing were used as objects to investigate real volume image reconstruction via stimulated Brillouin and stimulated Raman scattering. The laser beam illuminating the object (in both near and intermediate fields) was focused by a lens into two different regions: (a) inside the cell containing the nonlinear medium and (b) in front of the scattering cell. The real image reconstructed by the back-scattered beam was observed to be significantly different for the two regions. A higher quality of image reconstruction was obtained for grids having closer spacing as compared to that for a single metallic wire.

9:12

AF 2 The Investigation of Wavefront Reconstruction (WFR) by Two-Lens System. R. J. Lysiak, T. J. Wang and C. Y. Hsueh, Texas Christian U.--A two-lens system with a scattering object between two lenses was used to obtain Wavefront Reconstruction by stimulated Raman and Brillouin Backscattering (WFR-SS). The unique feature of this system is as follows: With the scattering object placed between two lenses, an image of the object is fixed at some point beyond the lens; by moving the first lens, the focus of the two-lens system can be varied continuously from near the second lens, through the image on to infinity. In all prior experiments reported in the literature the image of the object was formed beyound the lens focus. The image reconstructed by Stimulated Back-scattering was in agreement with the hologram model discussed previously.*

*Wang, T.J., Lysiak, R.J., Proceeding of International Conference on Lasers '82.

9:24

AF 3 **Discretization in the Quasi-Continuum.** R. S. BURKEY and C. D. CANTRELL, U. of Texas at Dallas[1]--For a quasi-continuum interacting semi-classically with an electric field, we have derived two distinct methods of reducing the number of levels in the system, thereby making computer calculations of the ground-state amplitude and of the complex polarization feasible for arbitrarily varying fields. One method applies in the case of bands with "long tails" and the other in the case of bands with "short tails".

[1]Supported by Robt. A. Welch grant AT-873

9:36

AF 4 SELF FOCUSING OF MULTIPLE INDEPENDENT BEAMS. D.R. ADAMS and C.D. CANTRELL, Univ.of Texas at Dallas.[1] --In a medium in which self focusing is observed, the same nonlinearity which gives rise to this effect will also make the superposition principle invalid. Thus multiple beams in such a medium will not propagate independently but rather will interact because of the nonlinearity. This may be significant in laser chemistry and laser isotope separation applications where it is common to use lasers operating at two or more different frequencies. We report the results of numerical calculations for two copropagating beams in a medium consisting of an ensemble of non-interacting ladder systems which has been shown to produce significant coupling between the originally independent beams [2].

[1] Research supported by the NSF under Grant Nos. CHE-8017324 and CHE-8215245

[2] D.R. Adams, C.D. Cantrell, and W.H. Louisell, Opt. Comm. 43 (1982) 292

9:48

AF 5 High Repetition Rate Nitrogen Ion Laser, R. C. HARSHAW and C. B. COLLINS, U. of Texas at Dallas. In this work the nitrogen ion laser has been operated at high repetition rates using an oscillator amplifier arrangement. The working media were dilute nitrogen plasmas pumped by charge transfer from helium that produced intense emissions at 427.8 nm from the B→X transition of N_2^+. The experimental system consisted of two such plasmas excited in corona-preionized TEA configurations. Command charging was incorporated to increase the operational lifetime of the stripline discharge device as well as that of the switching thyratron. Gas lifetime was extended by the addition of a multi-atmospheric longitudinal gas recirculation system and heat exchangers. The 20-cm oscillator and 1-m amplifier combination was capable of peak output powers in the megawatt level during the 5 nsec discharge. Repetition rates approaching 100 pps have the potential to yield high average power thus making this type of laser an ideal candidate for a dye laser pump. The characterization of the laser output as functions of repetition rate, pressure, discharge voltage, gas recirculation velocity, and gas lifetime are reported here.

10:00

AF 6 Tricritical Phenomena in Lasers. J.C. ENGLUND and W.C. SCHIEVE, U. of Texas at Austin*. -- Lasers containing a saturable absorber and dye lasers are examples of nonequilibrium systems having a tricritical point (the boundary between phase transitions of first and second order). An investigation is made of fluctuation phenomena near the tricritical point for the "good cavity" limit. A Fokker-Planck equation containing a fifth-order drift function and a constant diffusion function is used to model the field statistics. Near the tricritical threshold, scaling relations reduce the number of free parameters to two, and the approach to the tricritical point is made along the three critical lines. First, the photon statistics are treated. Then, the asymptotic eigenvalue problem is solved analytically; numerical integration is used in the tricritical region. From these results, spectral properties are determined, which include non-Lorentzian line shapes and a region of "anomalous" incoherence. Finally, the model is evaluated by a comparison with calculations based upon the one-mode quantum master equation, in which saturation effects are included to all orders; for realistic values of the parameters, the two approaches are in good agreement.

*Partially supported by the R.A. Welch Foundation.

10:12

AF 7 **Selective Excitation of Molecules with Slowly Varying Laser Pulses.** GARY L. PETERSON and C. D. CANTRELL, U. of Texas at Dallas--In recent years interest in laser excitation of molecules has risen with the prospect of applications in laser isotope separation and laser chemistry. We demonstrate that slowly varying (adiabatic) laser pulses may be effective in selectively exciting particular energy levels in a molecule. Analytic and computer solutions of the Schrödinger equation for various simplified models of molecules show population transferred to higher energy levels for laser fields which rise slowly from zero and cut off sharply, or pulses with adiabatic variations in both field strength and frequency. Laser isotope separation is explicitly shown for these models. Estimates

Discretization in the Quasi-Continuum

R. S. Burkey and C. D. Cantrell

Center for Quantum Electronics and Applications

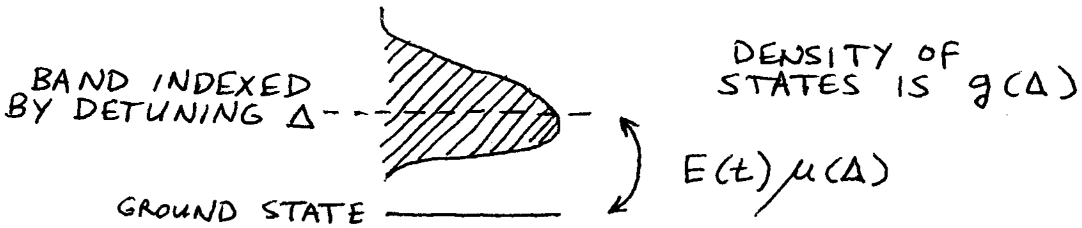
University of Texas at Dallas

Supported by:

Robert A. Welch grant AT-873.

The (1,Band) System

Consider a quantum system, consisting of a distinguished ground-state and a band of levels, which can interact semi-classically (*via* an electric field) with the ground-state but not with each other:



This system is widely studied because it is the natural next step after the two-level system. It can feature phenomena which two-level systems do not, such as recurrences and decay of the ground-state population.

Schrödinger's equations are:

$$(1) \quad \dot{a}(t) = i\,E(t) \int g(\Delta)\mu(\Delta)\, b(\Delta,t)\, d\Delta$$

$$(2) \quad \dot{b}(\Delta,t) = i\,E(t)\mu(\Delta)\, a(t)\,,$$

which are equivalent to the integro-differential equation

$$(3) \quad \dot{a}(t) = -E(t)\int_0^t E(t')\,a(t')\,\chi(t-t')\,dt'$$

$$(4) \quad \chi(t) = \int g(\Delta)\mu(\Delta)^2\, e^{i\Delta t}\, d\Delta \quad .$$

Discretization

If the band is continuous it must be approximated discretely before computer solution of Schrödinger's equation can be attempted. This is the inverse problem of that which *coarse-graining* methods tackle.

A Discretization Method

Suppose that the dipole matrix elements die to zero quickly as the detuning becomes large. Then we can define orthogonal polynomials using the dipole distribution (squared) as a weight function:

$$\delta_{nm} = \int \left[g(\Delta) \mu(\Delta)^2 \right] f_n(\Delta) f_m(\Delta) \, d\Delta \quad .$$

Orthogonal polynomials can be used as the basis for approximate integration schemes:

$$\int \left[g(\Delta) \mu(\Delta)^2 \right] f(\Delta) \, d\Delta \approx \sum_n w_n f(\Delta_n) \quad .$$

There is a uniform method for producing these approximation formulae *and* the error terms thereof.

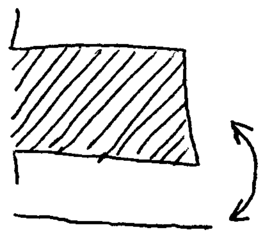
Equation (4) can be approximated using an integration scheme as

$$\chi(t) \approx \sum_n w_n e^{i\Delta_n t}$$

with a *known* degree of error. However, this is just the expression that would be derived from a *discrete* band, with detunings at the sample points and dipole matrix elements that are square roots of the weight factors. With this substitution we can discretize (1,band) systems.

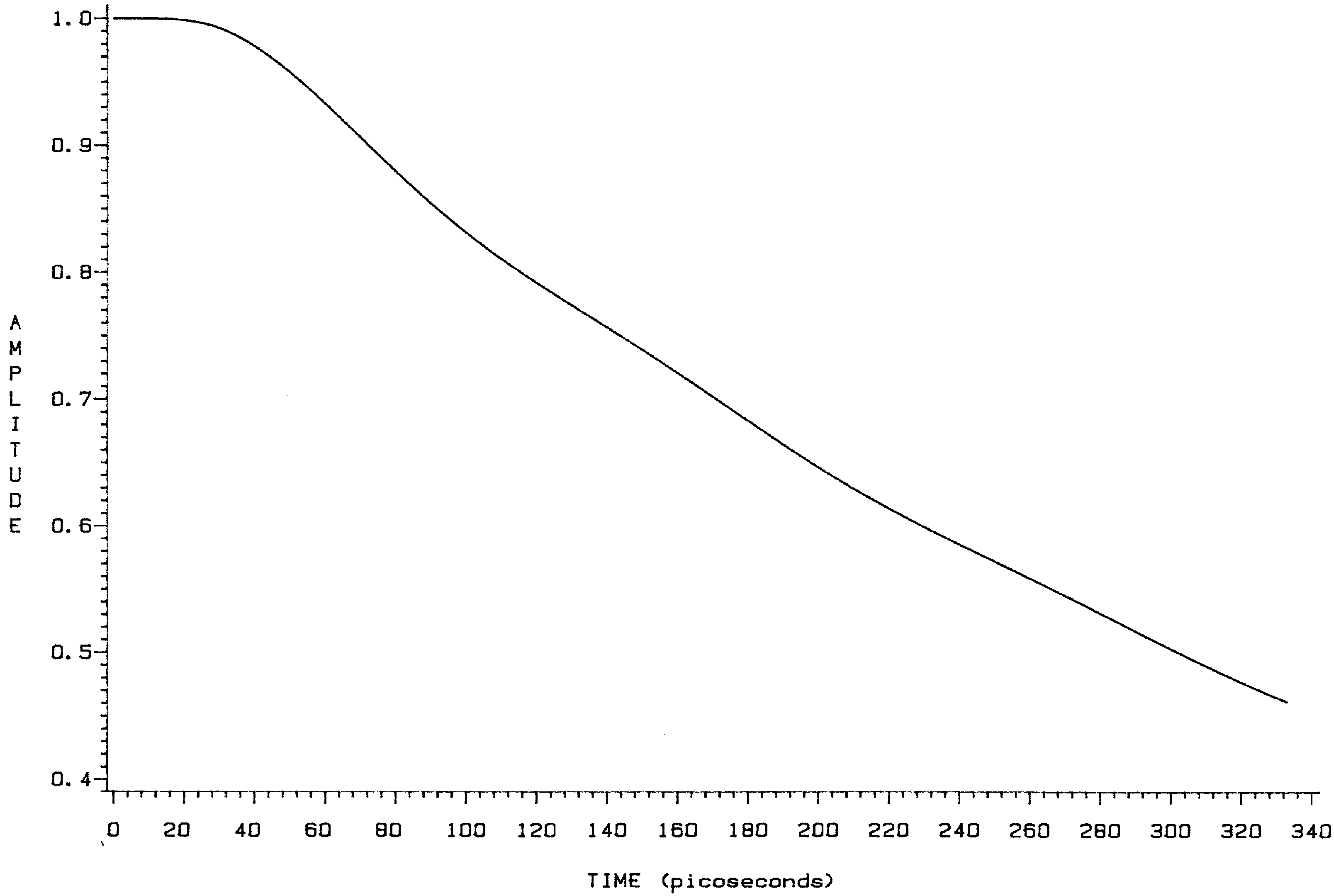
An Application

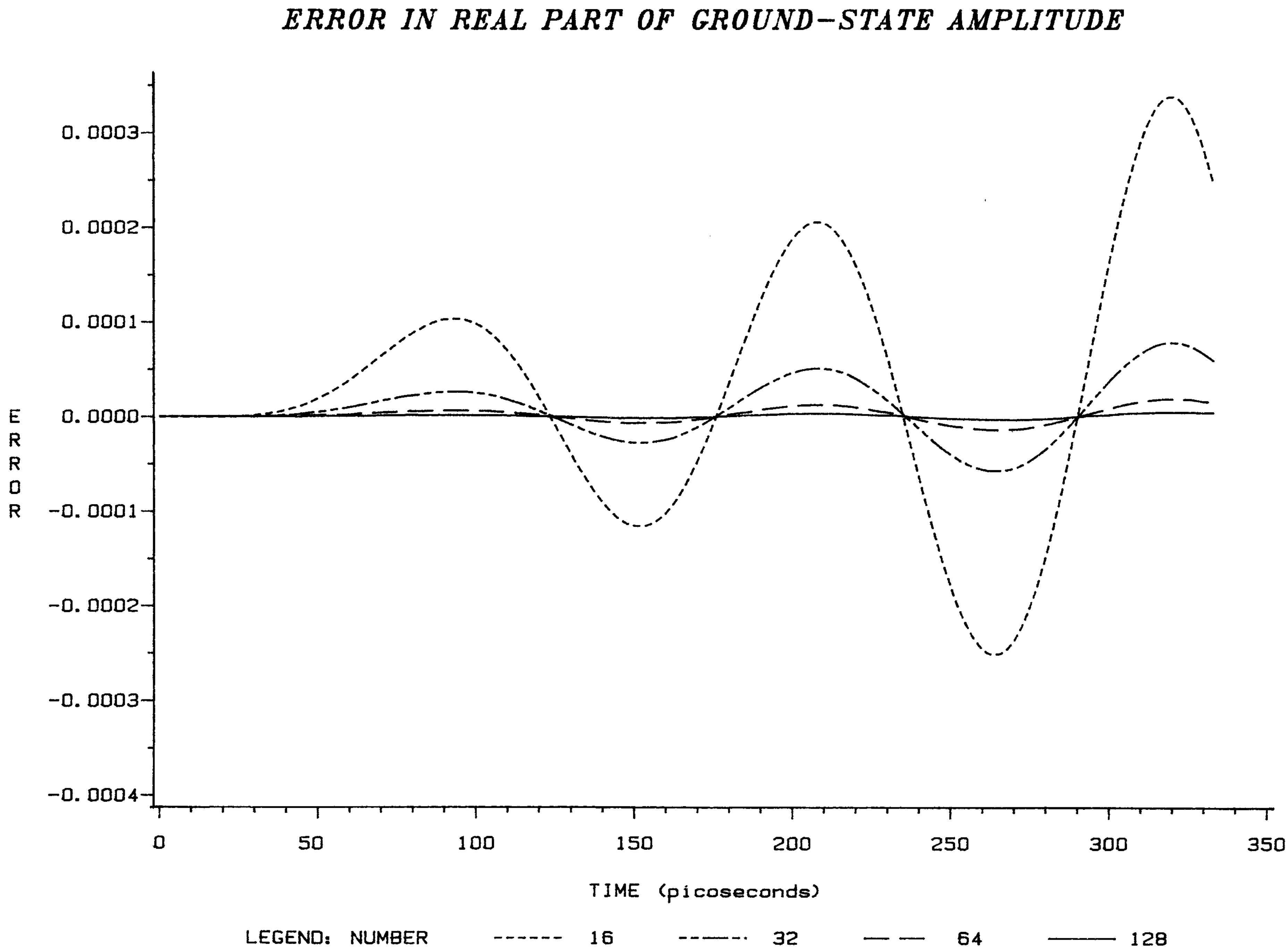
Consider the uniform rectangular band:



The natural competitor of our discretization scheme is *Rice Discretization*, which involves replacing the continuous band by evenly spaced discrete levels. We have calculated the error involved in Rice discretizations of 16, 32, 64, and 128 levels, as opposed to the correct discretization discussed above, which has 16 levels.

GROUND-STATE PROBABILITY AMPLITUDE




ERROR IN REAL PART OF GROUND-STATE AMPLITUDE
0.0003
0.0002
0.0001
0.0000
-0.0001
-0.0002
-0.0003
-0.0004
ERROR
0
50
100
150
200
250
300
350
TIME (picoseconds)
LEGEND: NUMBER
16
32
64
128

Summary

We have presented a method for replacing the continuous band in a (1,continuum) system by discrete levels, with a known amount of error. We have shown that the method is superior to discretization by replacement with evenly spaced levels. This method also works to reduce the number of levels in a (1,discrete) system, but we have not presented a numerical example of that case.