JUNE 18 JUNE 21

ADVANCE PROGRAM

CLEO '84
CONFERENCE ON LASERS AND ELECTRO-OPTICS

IQEC '84
XIII INTERNATIONAL CONFERENCE ON QUANTUM ELECTRONICS

CLEO/IQEC Exhibition
JUNE 19-21, 1984

ANAHEIM CONVENTION CENTER and
ANAHEIM MARRIOTT HOTEL
ANAHEIM, CALIFORNIA

JUNE 19 JUNE 22

10:30 AM-11:00 AM

ORANGE COUNTY BALLROOM

Molecular Dynamics
M. M. T. Loy, *Presider*
IBM Thomas J. Watson
Research Center

10:30 AM
ThDD1 Time-Resolved Raman Spectroscopy of Infrared Multiphoton Excited Molecules, E. Mazur, I. Burak,* and N. Bloembergen, *Harvard University.* Time-resolved Raman studies of collisionless multiphoton excited molecules show that collisionless vibrational energy redistribution between infrared and Raman-active modes occurs even at very low infrared fluence. Results for several molecular systems are presented.

*Permanent address: *Tel Aviv University, Israel.*

10:45 AM
ThDD2 Determination of the H + D_2 Product State Distribution Using a Novel Laser Ionization Mass Spectrometer, E. E. Marinero and C. T. Rettner, *IBM Research Laboratory,* and R. N. Zare, *Stanford University.* A novel differentially pumped time-of-flight spectrometer together with laser multiphoton ionization is utilized to determine the product internal-state distribution of HD in the hydrogen atom exchange reaction $H + D_2 \rightarrow HD + D$.

11:00 AM
ThDD3 Discretization in the Quasi-continuum, Ronald S. Burkey and C. D. Cantrell, *University of Texas at Dallas.* Quasi-continua and models of quasi-continua are of current interest in the problem of intramolecular relaxation during multiple-photon molecular excitation. We present two new methods for greatly reducing the number of energy levels that must be treated explicitly in analytical or numerical calculations of the dynamics of laser-pumped quasi-continua.

SALON E

Quantum Wells II
Y. Suematsu, *Presider*
Tokyo Institute of Technology,
Japan.

10:30 AM (Invited Paper)
ThEE1 Basic Properties of Quantum Wells, C. Weisbuch, *LCR Thomson CSF, France.* The two-dimensional nature of electronic states in quantum wells with its profound influence on optical properties is discussed. Implications for materials characterization and opto-electronic devices are reviewed.

11:00 AM (Invited Paper)
ThEE2 GaAlAs/GaAs Quantum-Well Lasers by Metalorganic Chemical Vapor Deposition, R. D. Burnham, T. L. Paoli, and W. Streifer, *Xerox Palo Alto Research Center,* and N. Holonyak, Jr., *University of Illinois at Urbana-Champaign.* A variety of quantum-well lasers, including infrared and visible, single- and multiple-stripe devices, is discussed. Emphasis will be on new results, including wavelength modification by thermal annealing, index guiding by impurity-induced disordering, and broadband tuning with an external grating.

SALON F

Nonlinear Spectroscopy II
C. A. Sacchi, *Presider*
Instituto de Fisica del
Politecnico, Italy

10:30 AM
ThFF1 Study of DABCO as a Possible Two-Photon Laser—Population Dynamics and Absorption Spectrum of the Excited *A* State, J. H. Glownia, G. Arjavalingam, and P. P. Sorokin, *IBM Thomas J. Watson Research Center.* The population dynamics and absorption spectrum of the excited state $\tilde{A}$ [3s(+)] of triethylenediamine (DABCO) vapor were measured with the aim of determining whether these parameters are compatible with possible two-photon amplification in this system.

10:45 AM
ThFF2 Phase-Coherent Laser Multiple-Pulse Spectroscopy, M. Banash, F. Loiaza, F. Spano, and W. S. Warren, *Princeton University.* Laser-pulse sequences with precisely determined relative pulse phases and pulse shapes measure population and polarization transfer through molecular collisions in I_2 or $I_2 + O_2$ and remove pulse-propagation artifacts in mixed crystals.

11:00 AM
ThFF3 Measurement of the Third-Order Susceptibility by Phase-Modulated Nonlinear Raman Spectroscopy, G. J. Rosasco and W. S. Hurst, *National Bureau of Standards.* A three-beam, phase-modulation technique for nonlinear Raman spectroscopy is used to measure the third-order susceptibility. The contribution of the D_2 Raman *Q* branch and the nonresonant backgrounds of A and N_2 are reported.

THURSDAY, JUNE 21, 1984

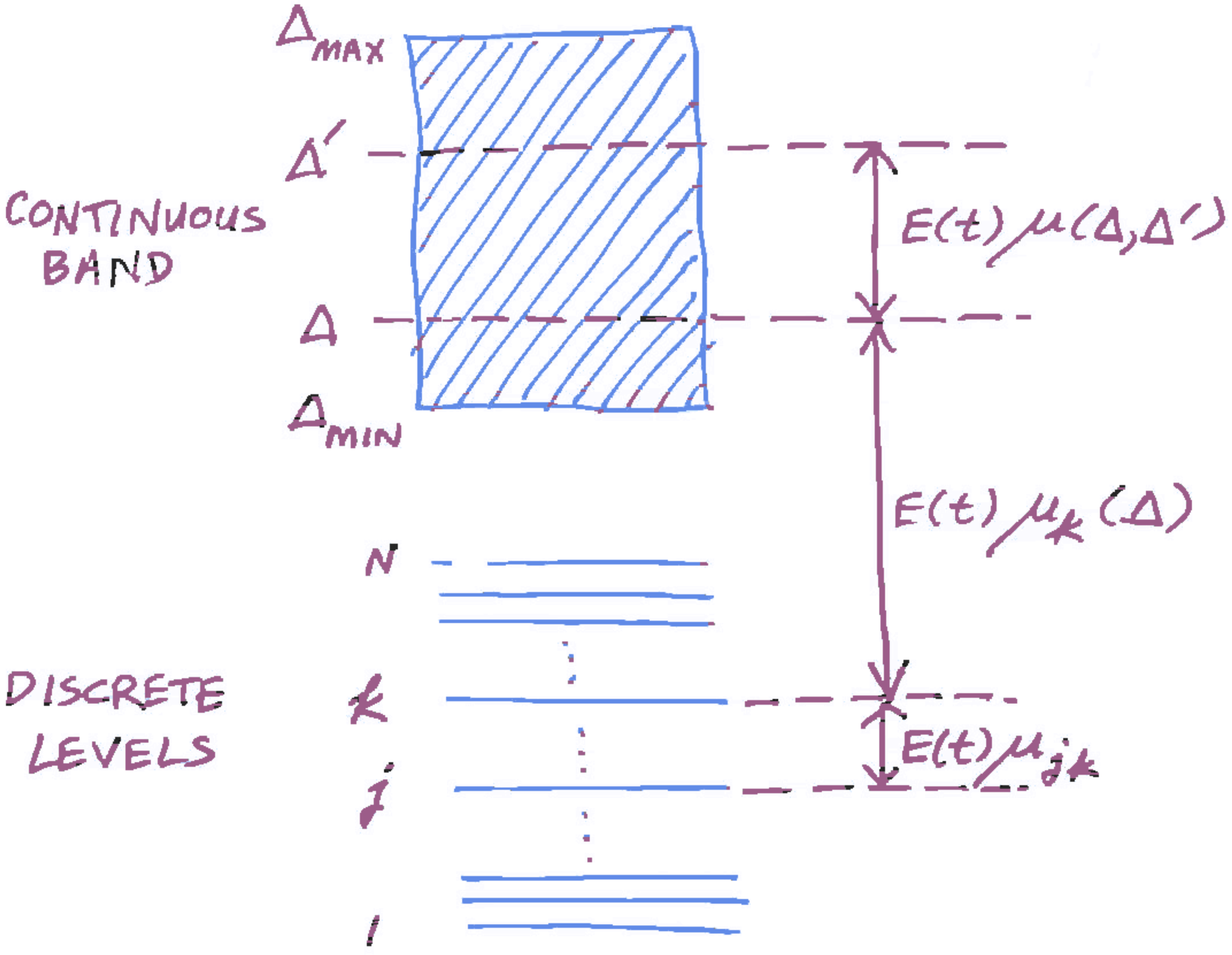
DISCRETIZATION IN THE QUASI-CONTINUUM

RONALD S. BURKEY
C.D. CANTRELL

CENTER FOR QUANTUM ELECTRONICS
UNIVERSITY OF TEXAS AT DALLAS

SUPPORTED BY: ROBERT A. WELCH FOUNDATION, GRANT AT-873.

SYSTEM CONTAINING ONE CONTINUOUS BAND, OF FINITE WIDTH:



$$H(t) = \underbrace{\delta}_{\substack{\text{DIAGONAL}\\ \text{MATRIX}\\ \text{OF}\\ \text{DETUNINGS}}} + \underbrace{E(t)}_{\substack{\text{ELECTRIC}\\ \text{FIELD}}} \underbrace{\mu}_{\substack{\text{DIPOLE}\\ \text{OPERATOR}}}$$

WEIERSTRASS APPROXIMATION :

$$\mu_k(\Delta) \approx \mu(\Delta)\, p_k(\Delta)$$

$$\mu(\Delta,\Delta') \approx \mu(\Delta)\mu(\Delta')\, q(\Delta,\Delta') .$$

HERE,

$\mu(\Delta)$ —— "OVERALL" SHAPE OF THE BAND.

$p_k(\Delta)$, $q(\Delta,\Delta')$ —— POLYNOMIALS.

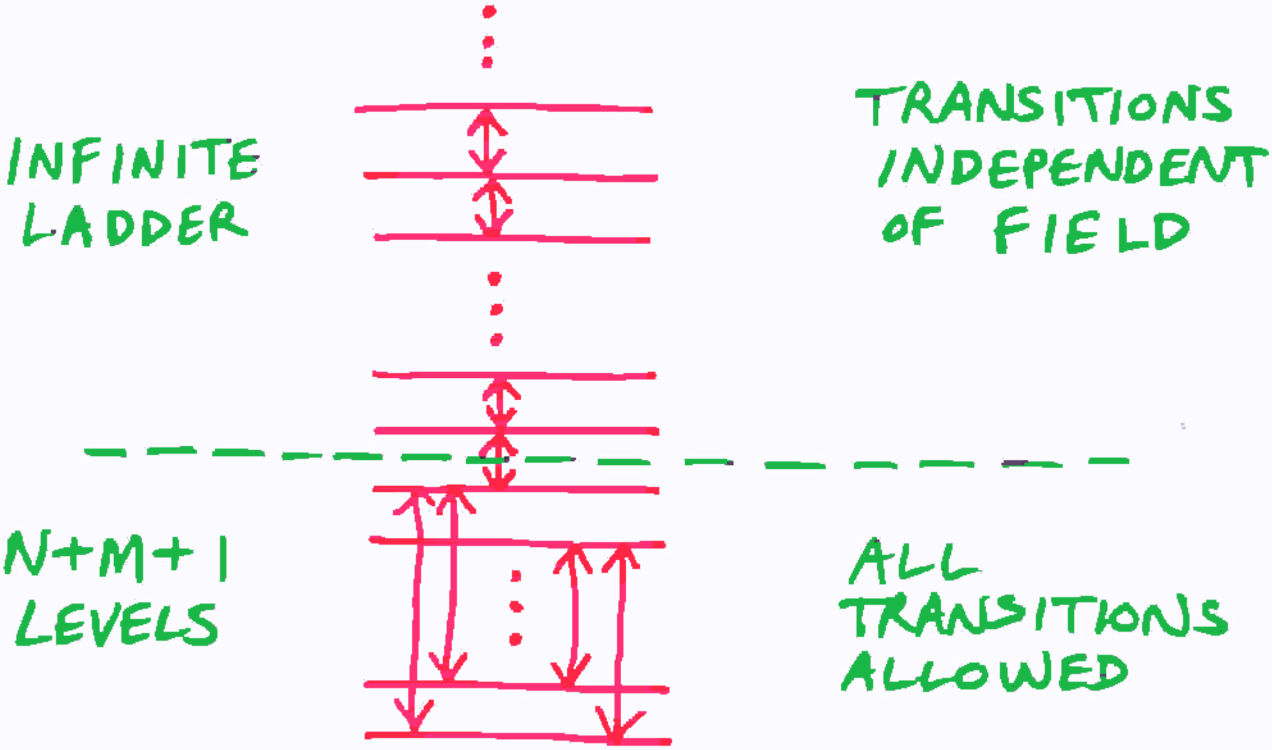
LET

M = MAXIMUM DEGREE IN Δ OF ALL THE $p_k(\Delta)$ AND OF $q(\Delta,\Delta')$,

AND

N = NUMBER OF DISCRETE LEVELS.

USING ORTHOGONAL POLYNOMIALS W.R.T. THE WEIGHT FUNCTION $\mu(\Delta)^2$, GET NEW "BASIS" IN WHICH:



CHOOSING

$$\mu(\Delta) = \begin{cases} \left[1 - \left(\frac{\Delta - s}{\sigma}\right)^2\right]^{+1/4}, & |\Delta - s| < \sigma \\ 0, & |\Delta - s| \geq \sigma \end{cases}$$

MAKES

$$H_{kk} = s$$
$$H_{k,k+1} = \sigma/2$$

IN THE LADDER.

TRUNCATION APPROXIMATION : USE ONLY A FINITE NUMBER OF LEVELS IN THE LADDER.

NUMERICAL EXAMPLE :

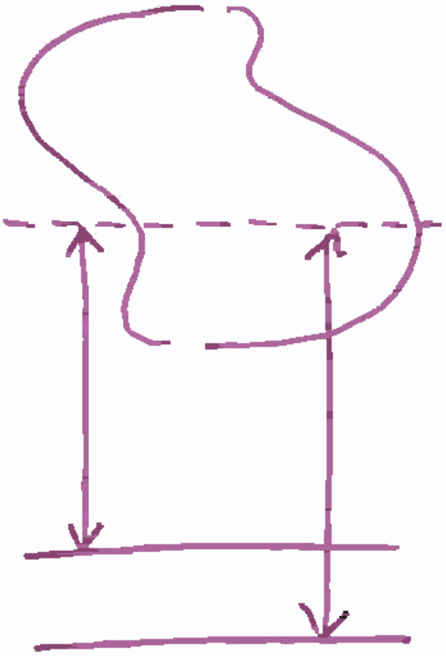
$N = 2$

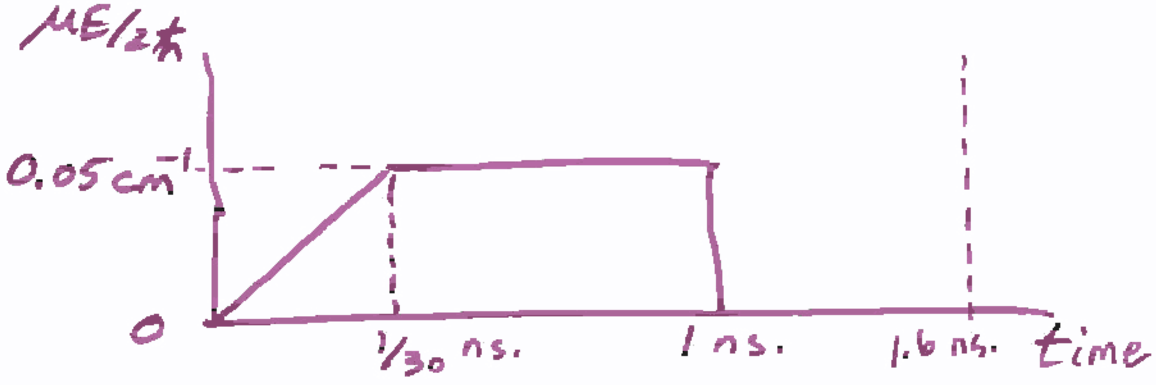
$M = 1$

$$P_1(\Delta) = \frac{u_0(\Delta) + u_1(\Delta)}{\sqrt{2}}$$

$$P_2(\Delta) = \frac{u_0(\Delta) - u_1(\Delta)}{\sqrt{2}}$$

$s = 0$, $\sigma = 0.3\ \mathrm{cm}^{-1}$.





SOLVE SCHRÖDINGER EQUATION IN NEW BASIS TO GET POPULATIONS.
TRUNCATE TO 100 LEVELS .

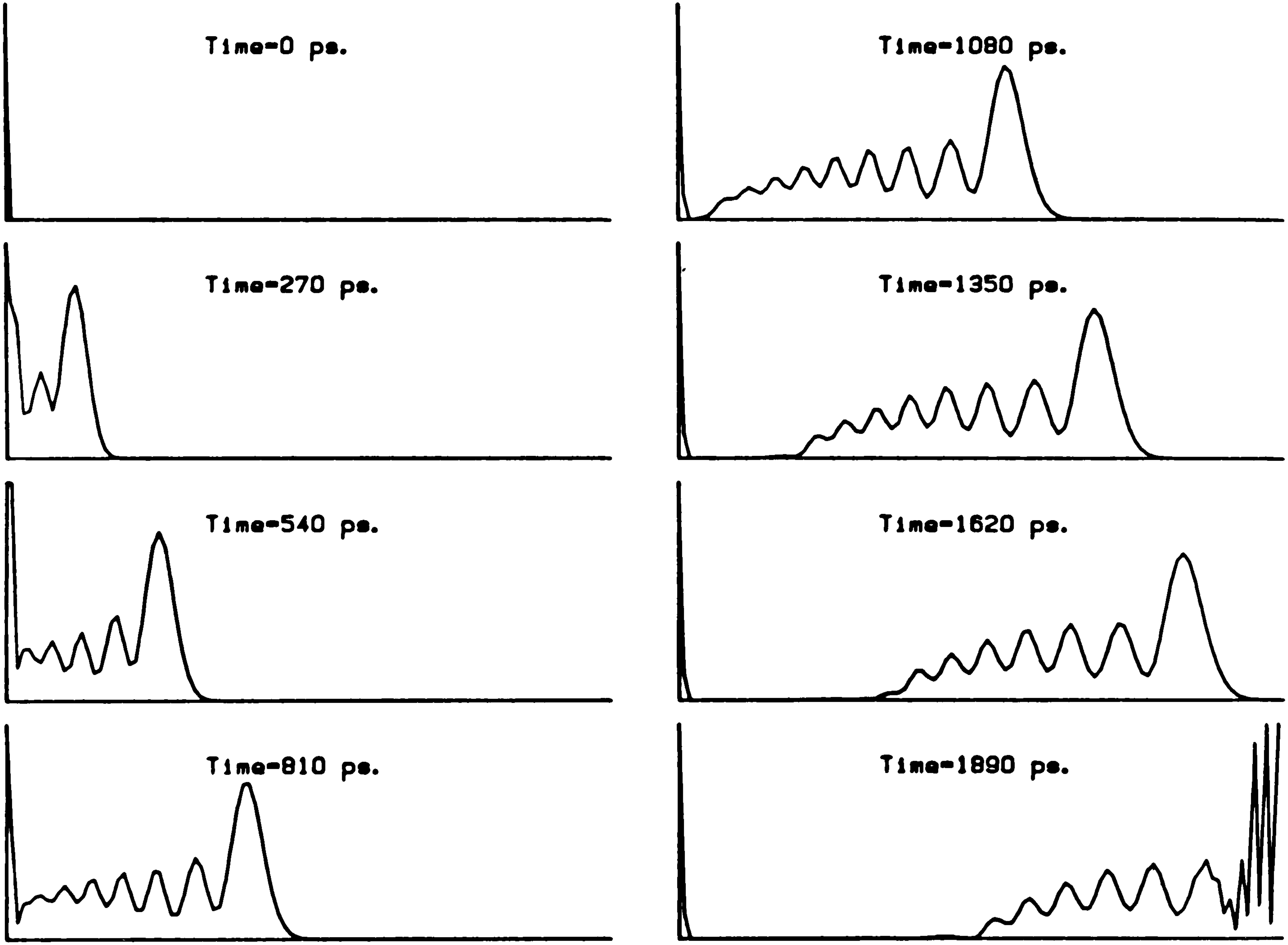

Time=0 ps.
Time=270 ps.
Time=540 ps.
Time=810 ps.
Time=1080 ps.
Time=1350 ps.
Time=1620 ps.
Time=1890 ps.

FIG. 4

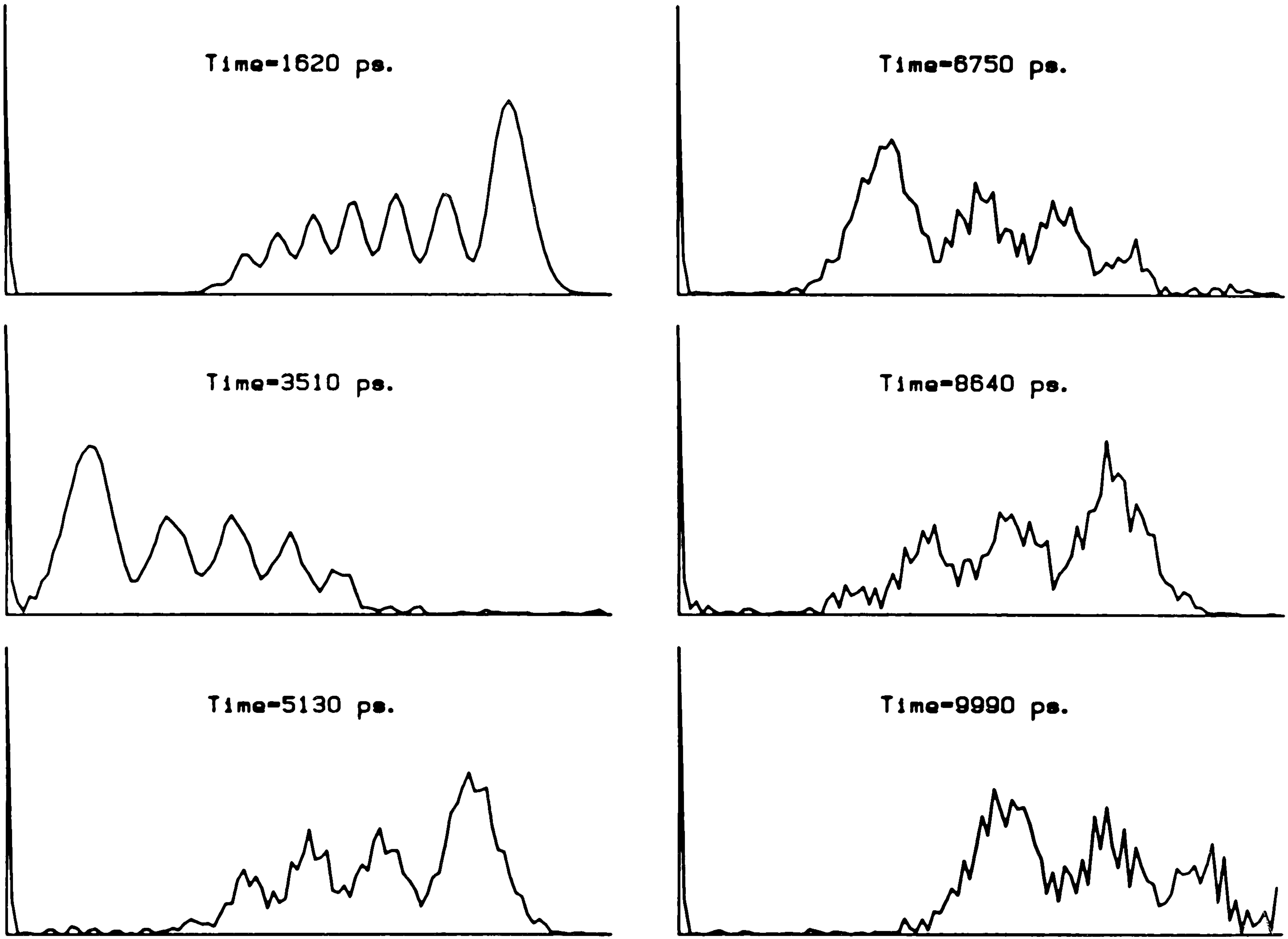

Time=1620 ps.
Time=3510 ps.
Time=5130 ps.
Time=6750 ps.
Time=8640 ps.
Time=9990 ps.

FIG. 5

EXPLANATION OF WAVE BEHAVIOR:

LET $a_n(t)$ BE PROBABILITY AMPLITUDE OF n-TH LEVEL IN NEW BASIS.

SCHRÖDINGER EQUATION FOR LADDER AMPLITUDES:

$$\dot{a}_n(t) = i\left(\frac{\sigma}{2} a_{n-1}(t) + s\, a_n(t) + \frac{\sigma}{2} a_{n+1}(t)\right).$$

TRY

$$a_n(t) = e^{i(\omega t - kn)} .$$

GET DISPERSION RELATION

$$\omega = s + \sigma \cos k .$$

∴, WAVE PACKETS TRAVEL WITH GROUP VELOCITY

$$v_g = \text{MIN or MAX OF } \frac{\partial \omega}{\partial k}$$

$$= \pm \sigma .$$

WITH NO TRUNCATION APPROXIMATION, PROBABILITY PACKETS MOVE UP THE LADDER FOREVER; OTHERWISE, THEY REFLECT.

SUMMARY: FOR A SYSTEM CONTAINING A FINITE-WIDTH CONTINUOUS BAND:

① THERE IS A "SIMILARITY TRANSFORMATION" WHICH, WITH THE WEIERSTRASS APPROXIMATION, TURNS THE BAND INTO AN INFINITE LADDER — EXCEPT THAT A FINITE NUMBER OF THE LEVELS ARE COUPLED IN A MORE COMPLICATED WAY.

② PACKETS OF WELL-DEFINED WAVES MOVE UP THE LADDER AT CONSTANT SPEED. IF THE LADDER IS TRUNCATED, THE WAVE PACKETS ARE REFLECTED AT THE TOP AND MOVE DOWN THE LADDER AT CONSTANT SPEED. THIS MAY BE VIEWED AS THE ORIGIN OF BOTH ERROR IN DISCRETIZATION OF CONTINUA AND RECURRENCES IN QUANTUM SYSTEMS.