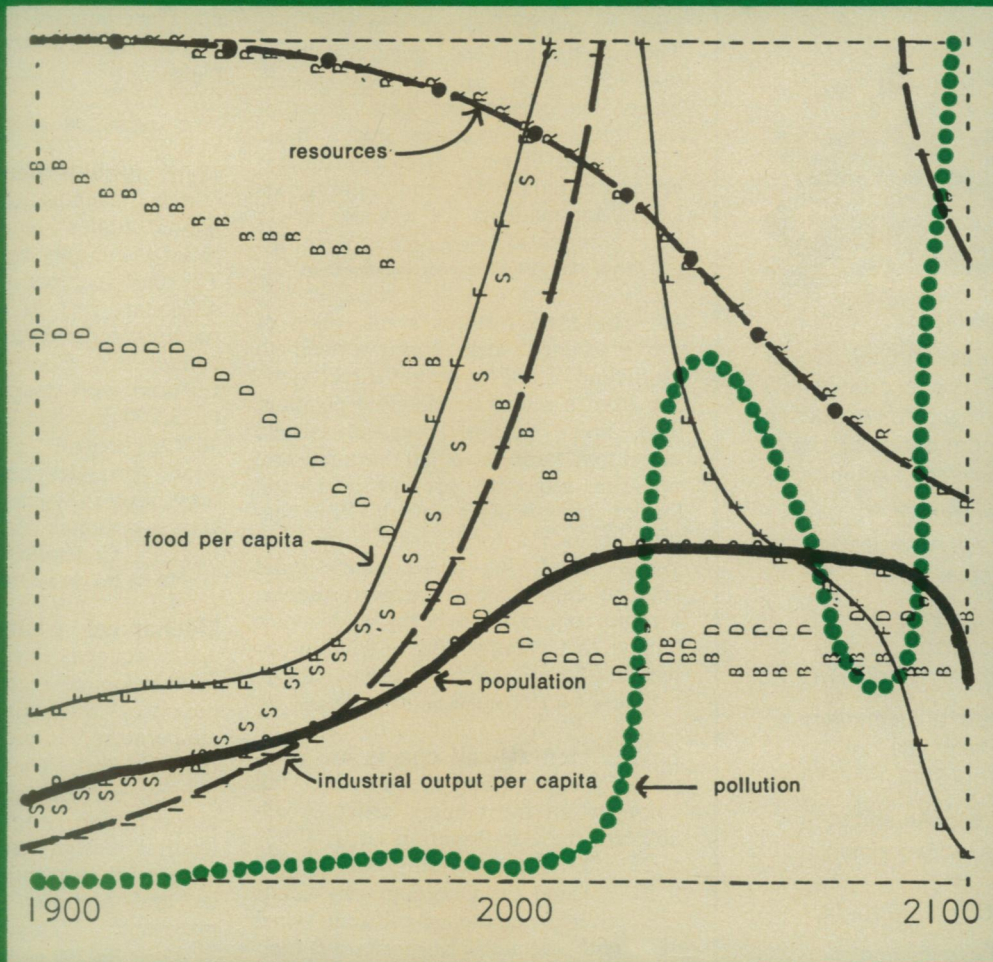


Site for radio astronomy array  
President's message on R&D  
Marijuana commission report  
Solid fuel for space shuttle



## Predicting limits to growth: How valid?

# science news®

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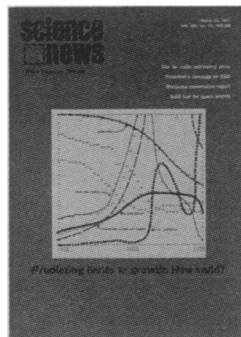
## IN SCIENCE FIELDS

**202** **Ecology:** The debate over doomsday

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The MIT/Club of Rome computer studies of the limits of growth predict that at current rates of expansion in industrialization, resource depletion, population, pollution and food consumption, mankind has at best 100 years before collapse. Critics charge severe oversimplification. See p. 202. (Graph projecting collapse from effects of industrialization even with unlimited resources, pollution controls, increased agricultural productivity and perfect birth control: Potomac Associates)

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**GASES AND HOW THEY COMBINE**  
Illustrates properties that distinguish gases and presents some simple integer ratios which lead, logically, to Avogadro's Hypothesis.  
#4103 Color, 22 min.

**GAS PRESSURE & MOLECULAR COLLISIONS**  
Explores the relationship between gaseous pressure and molecular collisions.  
#4106 B&W, 21 min.

**ELECTRIC INTERACTIONS IN CHEMISTRY**  
Illustrates the principles that opposite charges attract, like charges repel, and uncharged bodies have no electric interaction.  
#4109 Color, 21 min.

**CHEMICAL FAMILIES**  
Demonstrates methods by which chemical similarities among the elements have provided the basis for dividing them logically into families.  
#4112 Color, 22 min.

**MOLECULAR MOTIONS**  
Shows how properties are determined by the types of motion occurring at the molecular level.  
#4115 Color, 13 min.

**VIBRATION OF MOLECULES**  
Shows the relationship between the structure of a molecule and its vibrational motions.  
#4118 Color, 12 min.

**INTRODUCTION TO REACTION KINETICS**  
Illustrates the mechanisms of some simple chemical reactions.  
#4121 Color, 13 min.

**EQUILIBRIUM**  
Deals with three questions: What is chemical equilibrium? How does the chemist recognize it? How does he explain it?  
#4124 Color, 24 min.

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**CATALYSIS**  
Emphasizes that catalysts are typical chemical reactants, being unique only in that catalysts are regenerated during the reaction.  
#4127 Color, 17 min.

**ACID-BASE INDICATORS**  
The proton-donor-acceptor theory is used to interpret the experimental behavior of acid-base indicators.  
#4130 Color, 19 min.

**ELECTROCHEMICAL CELLS**  
Shows the construction and operation of an electrochemical cell.  
#4133 Color, 22 min.

**NITRIC ACID**  
Examines the properties of nitric acid.  
#4136 Color, 18 min.

**CRYSTALS AND THEIR STRUCTURES**  
Shows the principles and measurements by which actual crystal structures are determined.  
#4139 B&W, 22 min.

**MOLECULAR SPECTROSCOPY**  
Shows details of the infrared light absorption process and its relation to molecular properties.  
#4142 Color, 23 min.

**THE HYDROGEN ATOM—As Viewed by Quantum Mechanics (Standard Version)**  
Presents a description of the atom that is in accord with quantum mechanics.  
#4148 Color, 13 min.

**THE HYDROGEN ATOM—As Viewed by Quantum Mechanics (Advanced Version)**  
Includes the complete content of film #4148 plus a final section which contrasts the electron distributions of 1s, 2s and 2p orbitals.  
#4149 Color, 20 min.

**IONIZATION ENERGY**  
Presents two methods of measuring ionization energy: photoionization, and electron bombardment.  
#4151 Color, 22 min.

**SHAPES & POLARITIES OF MOLECULES**  
Observations are made of electric effects, including deflections of streams of liquids by a charged rod, and changes in charging time of a capacitor.  
#4154 Color, 18 min.

**CHEMICAL BONDING**  
Explains chemical bonding in terms of the electric interactions that cause the bonding in the hydrogen molecule.  
#4157 Color, 16 min.

**A RESEARCH PROBLEM: INERT(?) GAS COMPOUNDS**  
This film conveys the intense excitement and deep personal involvement of research in the stimulating context of the first synthesis of one of the inert gas compounds.  
#4160 Color, 19 min.

**SYNTHESIS OF AN ORGANIC COMPOUND**  
Shows the synthesis of 2-butanone, a ketone, from 2-butanol, an alcohol, as an example of a common type of organic synthesis.  
#4163 Color, 19 min.

**MECHANISM OF AN ORGANIC REACTION**  
Shows that the discovery of a reaction mechanism includes a determination of the chemical equation, the structures of the reactants and products, the fate of each atom of the reactants, and the structures of the intermediate molecules.  
#4166 Color, 20 min.

**BROMINE—ELEMENT FROM THE SEA**  
Explores the chemistry of an aqueous solution of bromine.  
#4169 Color, 22 min.

**VANADIUM—A TRANSITION ELEMENT**  
In this film vanadium is studied as a typical transition element.  
#4172 Color, 22 min.

**HIGH TEMPERATURE RESEARCH**  
Illustrates the excitement of discovering new knowledge through research by studying the bond strength of gaseous titanium monosulfide.  
#4175 Color, 19 min.

**TRANSURANIUM ELEMENTS**  
This film features four scientists who were principals in the discovery and identification of several of the transuranium elements.  
#4178 Color, 23 min.

**BIOCHEMISTRY AND MOLECULAR STRUCTURE**  
Demonstrates the role of molecular structure in determining biological activity.  
#4181 Color, 22 min.

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**TIME AND CLOCKS**

Presents concepts of time measurement and shows various devices used to measure and record time intervals.  
#0101 B&W, 28 min.

**LONG TIME INTERVALS**

A discussion of long time intervals with a detailed description of radioactive dating.  
#0102 B&W, 25 min.

**SHORT TIME INTERVALS**

A study of the extension of the senses to deal with very short time intervals.  
#0119 B&W, 21 min.

**MEASURING LARGE DISTANCES**

Points to the immensity of interstellar space, and suggests the complexities of measurement on this scale.  
#0103 B&W, 29 min.

**MEASURING SHORT DISTANCES**

Shows how calibration of instruments can give us accurate knowledge of small distances  
#0104 B&W, 20 min.

**CHANGE OF SCALE**

Demonstrates that change of size necessitates change in structure of objects.  
#0106 B&W, 23 min.

**STRAIGHT LINE KINEMATICS**

Discusses measurement and relationships of distance, speed and acceleration.  
#0107 B&W, 34 min.

**VECTOR KINEMATICS**

Velocity and acceleration vectors are introduced and shown simultaneously for various 2-dimensional motions.  
#0109 B&W, 16 min.

**ELEMENTS, COMPOUNDS AND MIXTURES**

A discussion of the difference between elements, compounds and mixtures, showing how a mixture can be separated by physical means.  
#0111 Color, 33 min.

**THE MASS OF ATOMS (PARTS I & II)**

Shows an experiment in which the masses of a helium atom and a polonium atom are determined.  
#0117 Part I B&W, 20 min.  
#0118 Part II B&W, 27 min.

**DEFINITE AND MULTIPLE PROPORTIONS**

Demonstrates the chemical laws of definite proportions by electrolysis and recombination of water.  
#0110 B&W, 30 min.

**CRYSTALS**

Demonstrates the nature of crystals, how they are formed and why they are shaped as they are.  
#0114 Color, 25 min.

**BEHAVIOR OF GASES**

The Brownian motion of smoke particles is shown by photomicrography and compared with a mechanical analogue.  
#0115 B&W, 13 min.

**RANDOM EVENTS**

Shows how the overall effect of a very large number of random events can be very predictable.  
#0116 B&W, 31 min.

**MEASUREMENT**

The measurement of the speed of a rifle bullet is used as the basis for a discussion of the art of measurement.  
#0105 B&W, 21 min.

**INTRODUCTION TO OPTICS**

Deals with approximation that light travels in a straight line and shows the four ways in which light can be bent.  
#0201 Color, 23 min.

**PRESSURE OF LIGHT**

A discussion of the Crookes radiometer and the effect that causes it to rotate.  
#0202 B&W, 23 min.

**SPEED OF LIGHT**

Measures and compares the speed of light in air and in water.  
#0203 B&W, 21 min.

**SIMPLE WAVES**

Pulse propagation on ropes and slinkies shows elementary characteristics of waves such as different speeds in different media.  
#0204 B&W, 27 min.

**SOUND WAVES IN AIR**

The wave characteristics of sound transmission are investigated with large scale equipment using frequencies up to 5000 cycles  
#0207 B&W, 35 min.

**FORCES**

Introductory to mechanics in general, this film foreshadows later work with kinds of forces  
#0301 B&W, 23 min.

**INERTIA**

Demonstrates Galileo's principle of inertia.  
#0302 B&W, 26 min.

**INERTIAL MASS**

A continuation of INERTIA, this film develops the relation that acceleration is inversely proportional to mass, with a constant force.  
#0303 B&W, 19 min.

**A MILLION TO ONE**

Demonstrates the exceedingly small force needed to accelerate and keep a nearly frictionless body moving.  
#0308 B&W, 5 min.

**FREE FALL AND PROJECTILE MOTION**

Explores the behavior of freely falling bodies from a dynamical point of view and concludes that Newton's Law is a vector relationship.  
#0304 B&W, 27 min.

**DEFLECTING FORCES**

Discusses nature of forces which produce curved paths.  
#0305 B&W, 30 min.

**PERIODIC MOTION**

From a number of periodic motions simple harmonic motion is selected for detailed examinations.  
#0306 B&W, 33 min.

**FRAMES OF REFERENCE**

Demonstrates the distinction between an inertial and non-inertial frame of reference.  
#0307 B&W, 28 min.

**ELLIPTIC ORBITS**

Using Kepler's law of areas, this film shows that the gravitational force on a satellite obeys an inverse square relation.  
#0310 B&W, 19 min.

**UNIVERSAL GRAVITATION**

The law of universal gravitation is derived by imagining a solar system of one star and one planet.  
#0309 B&W, 31 min.

**COLLISIONS OF HARD SPHERES**

A laboratory instruction film dealing with conservation of momentum primarily intended for teachers.  
#0319 B&W, 19 min.

**ELASTIC COLLISIONS AND STORED ENERGY**

Various collisions between two dry ice pucks are demonstrated. Measurements of the kinetic energy lead to the concept of stored energy.  
#0318 B&W, 27 min.

**MOVING WITH THE CENTER OF MASS**

Demonstrates the validity of the conservation of energy and momentum of several magnetic Dry Ice puck interactions.  
#0320 B&W, 26 min.

**ENERGY AND WORK**

Shows that work, measured as the area under the force-distance curve, does measure the transfer of kinetic energy to a body, calculated from its mass and speed.  
#0311 B&W, 28 min.

**MECHANICAL ENERGY AND THERMAL ENERGY**

Shows several models to help students visualize both bulk motion and the random motion of molecules, and explains the origin of the absolute temperature scale.  
#0312 B&W, 22 min.

**CONSERVATION OF ENERGY**

Here, energy is traced from coal to electrical output in a large power plant.  
#0313 B&W, 27 min.

**COULOMB'S LAW**

Demonstrates the inverse square variation of electric force with distance, and proves that electric force is directly proportional to charge  
#0403 B&W, 30 min.

**ELECTRIC FIELDS**

An electric field is discussed as a mathematical aid and a physical entity.  
#0406 B&W, 25 min.

**ELECTRIC LINES OF FORCE**

Shows how to produce electric field patterns using neon sign transformer as high voltage source.  
#0407 B&W, 7 min.

**MILLIKAN EXPERIMENT**

Simplified MILLIKAN EXPERIMENT described in the text is photographed through the microscope.  
#0404 B&W, 30 min.

**COULOMB FORCE CONSTANT**

Shows a large-scale version of the MILLIKAN EXPERIMENT.  
#0405 B&W, 34 min.

**COUNTING ELECTRICAL CHARGES IN MOTION**

Shows how an electrolysis experiment enables us to count the number of elementary charges passing through an electric circuit in a given time.  
#0408 B&W, 22 min.

**ELEMENTARY CHARGES AND TRANSFER OF KINETIC ENERGY**

In a diode using the identical geometry of the MILLIKAN EXPERIMENT, the gain of kinetic energy of electrons flowing from the cathode to anode is measured experimentally and found to be that predicted by the results of the MILLIKAN EXPERIMENT.  
#0409 B&W, 34 min.

**EMF**

Shows that the energy transfers demonstrated in film #0409 are independent of the geometry of the electrodes in the diode.  
#0430 B&W, 20 min.

**ELECTRICAL POTENTIAL ENERGY AND POTENTIAL DIFFERENCE (Parts I and II)**

In Part I of this film, the mechanism by which a battery establishes an electric field in a circuit is analyzed. In Part II, it is shown how the energy transformations in a steady current-carrying circuit can be obtained from measurements of potential difference and electric current.  
#0431 Part I B&W, 54 min.  
#0432 Part II B&W, 54 min.

**A MAGNET LABORATORY**

Shows equipment used in producing strong magnetic fields, and demonstrates magnetic effects of currents and the magnetism of iron.  
#0411 B&W, 21 min.

**MASS OF THE ELECTRON**

Shows how measurements are taken to calculate the mass of the electron with reference to the MILLIKAN EXPERIMENT.  
#0413 B&W, 18 min.

**ELECTRONS IN A UNIFORM MAGNETIC FIELD**

A spherical cathode-ray tube with a low gas atmosphere (Leybold) is used to measure the curvature of the path of electrons in a magnetic field.  
#0412 B&W, 11 min.

**ELECTROMAGNETIC WAVES**

Shows why we believe in the unity of the electromagnetic radiation spectrum.  
#0415 B&W, 33 min.

**RUTHERFORD ATOM**

Illustrates the historic Rutherford experiment which led to the nuclear model of the atom.  
#0416 B&W, 40 min.

**PHOTONS**

Here a photomultiplier and oscilloscope are used to demonstrate that light shows particle behavior.  
#0418 B&W, 19 min.

**INTERFERENCE OF PHOTONS**

Shows an experiment in which light exhibits both particle and wave characteristics.  
#0419 B&W, 13 min.

**PHOTOELECTRIC EFFECT**

Qualitative demonstrations of the photoelectric effect are shown using the sun and a carbon arc as sources.  
#0417 Color, 28 min.

**FRANCK-HERTZ EXPERIMENT**

A stream of electrons is accelerated through mercury vapor, and it is shown that the kinetic energy of the electrons is transferred to the mercury atoms only in discrete packets of energy.  
#0421 B&W, 30 min.

**MATTER WAVES**

Presents a modern version of the original experiment which showed the wave behavior of the electron.  
#0423 B&W, 28 min.