Thunder and lightning—the greatest natural sounds and lights

At the beginning of this century the relation of lightning to thunder was well established. The problem remained to determine how the sound was produced from the lightning striking.

Four principle theories were popular; a) the lightning stroke creates a vacuum, and thunder is produced when the vacuum collapses, b) the water drops in the path of the lightning flash are turned into steam and the rapid expansion of the steam is accompanied by a loud report. c) the electrical discharge decomposes water molecules by electrolysis and that the hydrogen and oxygen produced are subsequently recombined explosively, and finally, d) Thunder is the result of sudden heating of the air in the path of the lightning flash. Since air has an electrical resistance it can be heated by the passage of electricity in the same way that a wire or stove element is; the expansion of the heated air creates a shock wave which causes thunder.

The last explanation is now known to be correct. Each lightning flash heats the air in its path creating a stream of gases at high temperature and pressure. The expansion of the gases creates a shock wave that becomes an acoustic wave causing the sound of thunder. The other theories also contain some truth since lightning causes a reduced pressure and water (rain) is both evaporated and decomposed. However, these are minor effects compared to the shock wave.

Thunder begins in a channel of hot gases (up to 3,000 degrees celcius) at high pressures, (up to 100 atmospheres) caused by the lightning flash. At first the high pressure core expands as a shock wave. This wave compresses and heats the air and increases the speed of sound. The shock wave relaxes to an acoustic wave which reflects the energy of the lightning stroke. The more powerful the stroke, the lower the pitch of the resulting thunder.

The sound of thunder has many variations due to atmospheric conditions. The effect of air temperature, density and water content can cause refraction, reflection and attenuation of the thunder. This creates the variation in the sound that we hear.

With only a wrist watch, the location of a lightning flash may be determined. Measure the time in seconds between seeing a lightning flash and hearing the first thunder. The approximate distance in kilometers is given by the time in seconds divided by three, the distances can be determined in miles by dividing the time by five.

To photograph lightning set a camera on a tripod and point it to the most active area of the storm, close the iris to the smallest aperature possible (largest f number), focus at infinity and make time exposures from 20 to 30 seconds.

Be careful in a thunderstorm. Do not become an active participant in lighning storms by standing in open country, near trees, power lines, fences or other likely objects to be struck. The safest observation point is in a closed space such as a building or automobile away from walls and conducting surfaces.

YORKSCIENCE YORKSCIENCE

Lasers used to blast molecules

Richard Dubinsky

A basic understanding of how lasers operate and their effects on matter is a topic of high interest in York's Physics and Chemistry Departments.

The word LASER is an abbreviation for Light Amplification by Stimulated Emission of Radiation. The laser is a relatively modern device that is becoming readily available and finding numerous uses—from death ray weaponry to price determination in your local supermarket.

A laser is basically a concentrated beam of light having a high intensity. The laser light is produced by energizing atoms to an excited state with electrical discharges or high intensity lamps (stimulation) and allowing them to release their energy and return to a normal state all at once. Under these conditions a uniform beam of light is emitted.

Depending on the initial energy imput, the laser intensity can vary from punching holes in armour plate to doing delicate eye surgery.

Dr. Fred Morgan of York's Physics Department explains: "We are conducting laser research to find out basically two things—how the laser operates and how to use it as a tool."

Dr. Morgan uses a dye laser, having a cell built into the laser cavity. Unlike most lasers, which emit a monochromatic (single colour) beam, the dye laser uses a coloured substance (dye) that creates lasing action over a wider wavelength (colour) range. The laser cavity is the region in a laser where the actual excitation leading to a laser beam takes place. In this region Dr. Morgan placed a cell where gases or chemicals may be admitted and the effect of their behaviour on the laser light can be observed while the laser operates. This study is called "intracavity absorption".

By measuring the effect of laser light on a substance in the cell over very short time periods, a good understanding of reaction rates and decomposition of molecules can be achieved.

"The molecule absorbs the laser light and breaks up," explains Dr. Morgan. "This is the fundamental study of how energy is distributed in a molecule before it falls apart. The next step is to use polarized light."

Unlike normal laser light which has the effect of a hammer on a molecule, polarized light has a well defined direction and should act like a knife on a molecule. These experiments require precise time control in the range of millionths-of-a-second and highly sophisticated electronics. A PhD student from Poland, Boguslau Byszewski, is currently working with Dr. Morgan on this problem. These experiments will help provide a much clearer understanding of the nature of matter.

York's Chemistry Department has a high interest in laser research. Dr. Chester Sadowski has been using lasers as tools to produce radicals (highly reactive molecules existing for only short periods of time) in large quantities to study new molecules and reactions. He is currently on sabattical leave at Cambridge University in England. Dr. Steve Filseth and Dr. Tucker Carrington are also using lasers to study the reaction rates for various esoteric molecules in the vapour phase at low pressures. This work will lead to a better understanding of the reactions in the upper atmosphere, as well as combustion processes such as those that occur in automobile motors.

The lasers being used at York are manufactured in Canada by Lumonics or designed and assembled by the researchers themselves. Dr. Morgan believes that there is a very promising future in this field. "We are only scratching the surface of how lasers work and how molecules behave."

Jim Agnelli

Graduate student Boguslau Byszewski using pulsed dye laser in order to study molecular absorption.

Science Milestones

From Steacie Science Library

October 4, 1957
First satellite Soviet Sputnik goes into orbit.

October 11, 1889
James Prescott Joule died; determined the mechanical equivalent of heat.

October 13, 2128, B.C.
Earliest recorded solar eclipse observed by Chinese

October 25, 1923
Canadians Frederick Banting and J.R. McLeod named Nobel Prize Laureates for their discovery of insulin.

October 10, 1731
Henry Cavendish was born. Calculated the gravitational constant, and therefore, the mass of the earth.

October 14, 1632
Anthony van Leeuwehoek was born. Perfected the microscope and was first to observe one-celled microscopic life.

October 27, 1951
First treatment of cancer by cobalt bomb.

October 28, 1914
Jonas Salk was born. Produced the first successful vaccine against polio, first used in 1955.

Canatech '81

Glenn Strazds

A dazzeling display of Canadian high tech was held last week downtown at the Sheraton Centre. The show was presented in conjunction with a conference of electronics manufacturers.

The Canada Tech show was held for the first time here in Toronto. The participants were wholly owned Canadian companies, mainly displaying sophisticated electronic and computer wares. Some of the highlights of the show included The Canadian Advanced Technologies Association (C.A.T.A.), a new association comprised of high tech manufacturers including modern electronic and computer services. CATA, the Ontario Ministry of Industry and Tourism co-sponsored this event.

Companies such as Spar Aerospace, Northern Telecom and Telstat (communication firms) were there to show off their advanced technology. Optech, a company owned by Dr. Carswell (Physics Professor at York) was also represented at the show. Optech's work is related to Lidar (Light detection and Ranging) a form of laser radar, used to measure pollution, smoke, the depth of seawater and iceberg profiles. The show was dominated by computer and intigrated circuit manufacturers.
This show and others like it are good for Canada's development. It provides access to a market and the opportunity to display Canadian Technology. When I asked a participant what they though the Americans would think of this, they said "Who cares what they think."