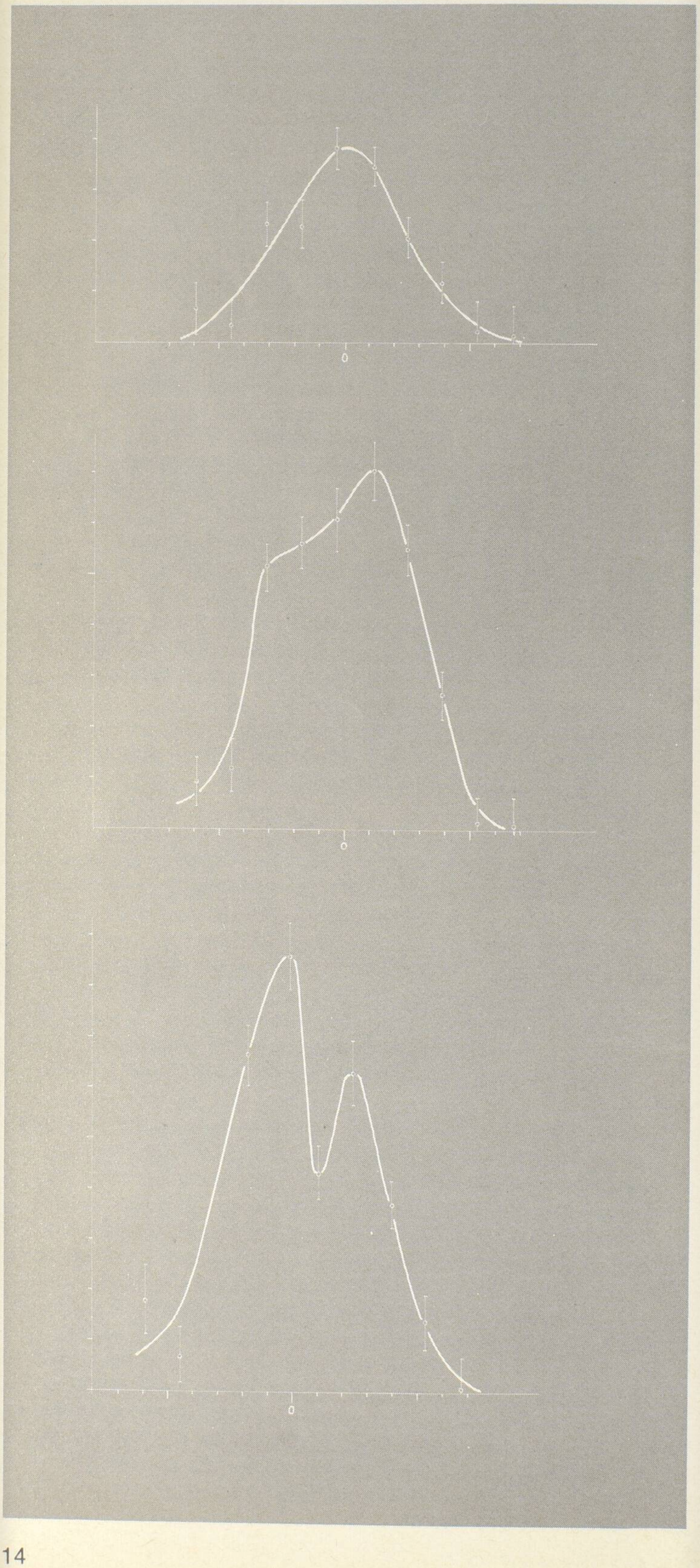
NRC laboratories and

Fourth state of matter



The days when matter was described solely in terms of solids, liquids and gases are gone forever. When gases are heated to very high temperatures they ionize, that is electrons are pulled off the constituent neutral particles and exist independently. Although the resultant mass remains electrically neutral, the individual particles are charged, so that the whole mass conducts electricity and is influenced by electric and magnetic fields. This is a new state of matter — the plasma.

Although long ignored (Langmuir proposed the name as recently as 1928), plasmas actually constitute the most common state of matter in the universe. Some scientists consider them to make up 99.9 per cent of all matter. Many feel that plasma studies are the key to the production of energy by thermonuclear fusion — cheap, very plentiful, comparatively pollution-free energy. Energy which may well call the tune in the coming decades.

The National Research Council of Canada is actively involved in several areas of plasma research. In the Laser and Plasma Physics Section of NRC's Division of Physics, a research team headed by Dr. A.J. Alcock and Dr. Benedict Kronast is making, analysing and photographing plasmas with the help of lasers. Lasers make plasmas surprisingly well. This is chiefly because, in principle, all the energy of a laser beam can be concentrated within a volume having dimensions of the order of an optical wavelength. For example, commercially available lasers can pack a punch

The wavelengths of laser light scattered after passing through a plasma give information about how ion waves are behaving in the plasma. In the spectra at left, the y-axis indicates scattering intensity and the x-axis, the wavelength in Angstroms. (The "O" corresponds to the wavelength of the incident laser radiation). The "regular" spectrum at top is characteristic of laser light scattered by an otherwise undisturbed plasma. With the other spectra, the plasma was perturbed by emission from a carbon-dioxide laser. The graph at bottom shows that two distinct ion waves (like sound waves) resulted from the disturbance. The two peaks indicate two ion waves propagating in opposite directions.

Les longueurs d'onde de l'émission du laser diffusée par un plasma permettent de mieux connaître le comportement des ondes ioniques dans le plasma. L'axe des ordonnées des spectres à gauche représente l'intensité de la lumière diffusée alors que l'axe des abscisses donne la longueur d'onde. (Le zéro indique la longueur d'onde du rayonnement incident provenant du laser). Le spectre, en haut, caractérise la lumière diffusée par un plasma ne subissant aucune autre perturbation. Quant aux autres spectres, le plasma a été perturbé par l'émission provenant d'un laser à gaz carbonique. Le spectre en bas démontre la présence de deux ondes ioniques (semblables à des ondes acoustiques) et les deux sommets signifient que ces ondes se propagent en directions opposées.