junction with the Carnegie Institution's Mt. Wilson Observatory.

We must be satisfied with surface temperatures, Prof. Russell explains, because we can look into a star only through a small mass of its atmosphere. If our atmosphere were as opaque as the hot atmosphere of a star we could see only a few feet in it. The opacity is due largely to the abundance of free electrons and ions which are partly separated from each other on account of the high temperatures. The extent of this so-called ionization can be calculated according to the law of mass action which has proved so powerful in studying chemical reactions.

The extent of the ionization also determines the character of the spectrum. Prof. Russell described how certain lines in the spectrum at first became stronger as the temperature increased and then became weaker again. By studying the relative strength of many lines he tells how hot a star is. By this method he expresses in degrees the temperatures of many stars which have previously been classified only as to color.

Using this information, Prof. Russell is able to determine the relative abundance of different elements in the stars. It turns out that hydrogen, for example, is usually a thousand times more abundant than all the metals put together.

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METEOROLOGY

Trees Protected By Lightning Rods

PROTECTION against lightning has been given to a number of fine trees in Maryland, some of them of historic interest, by equipping them with lightning rods. Success with this method over a period of seventeen years is described by Dean J. B. Whitehead of the Johns Hopkins University engineering faculty, in *Science*.

The equipment is quite simple. Seven-strand copper cable is led to the top of the tree, its end unbraided to give a number of free discharge points, and the lower end soldered to the top of an iron pipe driven eleven feet into the ground. Some trees have been given several such rods. Several of the trees thus equipped had been struck by lightning one or more times before the installation of the rods, but since then no protected tree has been struck, though in some cases other trees near by have suffered.

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CHEMISTRY

Blush of Green Solution Betrays Poisonous Lead

LEAD, a poison against which our food, drugs and cosmetics have to be guarded with ever-increasing vigilance, is now made to betray its presence by the red blush it causes in a greenish solution of one of the aniline dyes, diphenyl-thio-carbazone, called "dithizone" for convenience by the chemists. The new test, which has the double advantage of being both delicate and quick, was described before the meeting of the Association of Agricultural Chemists by H. J. Wichmann, of the Food and Drug Administration, U. S. Department of Agriculture.

Food and drug analysts often have to determine whether or not a shipment of fruit is carrying more than the tolerated minimum of lead-spray residue. They cannot take more than a few hours for this. Yet hitherto the quickest accurate lead-determining technique demanded several days. To deliver themselves from this dilemma they made their search for a new and quicker method.

The dye "dithizone" has been known for a long time; it was first described in Germany by the famous chemist Emil Fischer. Fischer even noted the red precipitate caused by the addition of lead. But so far as is now known, nobody had previously discovered the beautifully delicate gradations of color, from the solution's original green through blue and purple to cherry red, that occur when a lead solution treated with ammoniated cyanide is added to a solution of the dye containing chloroform. By matching hues with other

tubes containing a known amount of lead-dithizone, the chemists can now determine in a very short time exactly how much lead an "unknown" sample contains. The error involved in this operation has been determined as within four per cent.

The dithizone reaction is practically specific for lead. If the suspected sample contains tin or thallium, there may be some interference; but these elements can be eliminated in preliminary steps. A modification of the method, using formic acid instead of chloroform, gives promise of yielding equally accurate determinations for mercury, another poison frequently encountered in food and drug work.

Dithizone has hitherto been manufactured only in Germany, and is exceedingly expensive, the cost of the pure product delivered in this country being about $400 a pound. However, chemists at the University of Maryland have undertaken its manufacture, and have already succeeded in making enough of it for all official needs.

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Although more males than females are born in the United States, by the time the age of 75 is reached there are more women survivors than men.

Fragile porcelain has been developed scientifically until spark plugs stand chilling at 120 degrees below zero and then heating at 1800 degrees above.

Archaeologists are uncovering the road around the walls of Pompeii, removing tons of earth that earlier excavators dumped there when they cleared the buildings.

ASTRONOMY

Terrific Packing Job Pictured In Making of Spiral Nebulae

VAST FLOCKS of stars, each aggregation containing enough matter to make at least ten billions of suns such as our own, and perhaps even thirty billions. Such were the bewildering figures used as points of departure in a discussion of the expanding universe by Abbé Georges Lemaître of Louvain University, presented before the meeting of the National Academy of Sciences.

The spiral nebulae, those beautiful whirls of stars that race through space at almost unimaginable distances, are of such orders of magnitude; of the smaller mass if one accepts the data of one American astronomer, Dr. Edwin P. Hubble of Mt. Wilson Observatory, of the larger if one follows another, Dr. Harlow Shapley of Harvard College Observatory.

Abbé Lemaître was developing his theory of the expanding universe, which calls for a concept of matter rushing asunder through space, of such low density that the average is only one atom to a cubic yard, which would mean an energy equivalent to about the temperature of liquid hydrogen—only a few degrees above absolute zero. The velocity of this explosive outrush is not uniform in all regions, but falls off "locally" to a low critical figure, resulting sometimes in a sort of cosmic collapse. In such collapses the widely dispersed matter can aggregate into gases, dust, meteorites; these pile themselves into larger masses, the suns — and groups of nebulae are born. (*See SNL, Nov.* 25, 1933, *p.* 34)

All the spiral nebulae are approximately equal in mass, Abbé Lemaître's calculations indicate. Their spatial size, also, is of the same order of magnitude —about a thousand light-years in diameter. This may strike one as being rather immense, but into that boundary of a thousand light-years is packed all the matter that once occupied a block of space of 80,000 light-years' diameter.

The packing process requires the conversion of a certain amount of the mass into energy—something like six per cent. of the matter had to be thus dissipated. If there had been stars already in existence in the space, the energy output could not be accounted for, said Abbé Lemaître. But since the "packing" started with matter so widely dispersed that the best of our laboratory vacuums seems terrifically crowded with stuff by comparison, inelastic collisions, producing heat, could occur enough to meet the requirements of the theory.

The galaxy to which the earth's mother, the sun, belongs is a somewhat peculiar one, the Abbé's discussion brought out. Theoretically, partial collapses of space are possible as well as total collapses—mere slowings down of parts of the expanding universe. Within these slowed-down regions there can be local collapses, one of which gave birth to our own galaxy.

One consequence of Abbé Lemaître's study is of practical interest to astronomers. They have long been concerned with the problem of dark matter in space. If there is much of it, obviously space is only imperfectly transparent to the light from distant stars and nebulae. But if there is little, space can be regarded as completely transparent, for all practical purposes. Although there are known to be aggregates of dark matter that are quite dense, and hence light-stopping, Abbé Lemaître's figure giving an average distribution of matter of only one atom to a cubic yard leaves space most reassuringly transparent.

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