The Universe of Galaxies
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for
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During
~~For~~ the past few months, you have, no doubt, noticed that on Sunday mornings, in church, in the Mass the first words ~~of the Mass~~ recited in English, by the priest, are, most frequently, taken from the Psalms. For instance, last Sunday they were: SHOUT JOYFULLY TO GOD, ALL YE LANDS, SING THE GLORY OF HIS NAME (Ps. 65, 2). Next Sunday they will be: SING TO THE LORD A NEW SONG, BECAUSE HE HAS DONE WONDERFUL THINGS (Ps. 97, 1).

The psalms are songs. Forty of them, at the very least, were composed by the prophet David, who, ended his days as King of Israel.

David did not inherit his crown. His father was not a king. David was not born a prince. His father was a farmer, and David was trained to be a shepherd. When he was a boy, he used to watch the sheep by day. When he was a teen-ager, he used to guard them at night.

Out in the open air, David played his little Hebrew harp. As he played, he sang. ~~He became known~~ He made quite a name for himself as a singer. He was not as extensively known as the beatles are to-day, but he was known as the sweetest singer in Israel. He was summoned to the Royal

Household. His songs, with music, pleased the King. He was appointed Royal Musician. Soon, it became apparent that he had other qualities. He was strong as an ox. He was as courageous as he was strong. He became a great warrior. Miraculously, he was chosen as successor to the king of his tribe, Saul, King of Juda, and later he was recognised as King of all Israel. A Number of David's songs have come down to us. Some, probably, were composed when he was a youth. All are coloured by the memories of his teen-age years, when he used to tend his father's sheep by night.

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Some evenings, as David started his vigil, the full moon would be in the Eastern Sky. He would watch it throughout the night. Slowly it would climb in the sky, until it was in a southerly direction, after that, slowly it would descend towards the west. On these nights of full moon, the moon's approach to the West was a sign that dawn would soon be coming.

Other nights, namely on nights soon after the New Moon, at the start of the night watch, the moon would be a crescent, in the western sky. David would watch it sink in the West, leaving him alone for the remainder of the night, with nothing above him but the myriad of stars. He would watch the slow parade of stars, as the constellations in the East climbed the sky, passed the South, and headed towards their setting in the West. On those nights, the first sign of approaching dawn was the fading from

the sky of the fainter stars. Their fading was followed by a glow in the Eastern sky, growing into the wondrous reddening of the dawn, which precedes the rising sun. And David sang: THE HEAVENS DECLARE THE GLORY OF GOD, AND THE FIRMAMENT (of stars) PROCLAIMS THE WORK OF HIS HANDS. (Ps. 18, 2).

Our Father, Who is in heaven, is a good Father. And He is a patient teacher. To all His children, down through the ages, He has spoken, and speaks, a language accommodated to our minds. And, always, as we grow mentally, He has other lessons in store for us.

A few centuries after David's time, the Greek mathematicians became intrigued by the wanderings of the Planets in the sky. Indeed, it was they who called them 'Planets', or, in Greek, Planétai, which means 'Wanderers'.

At the beginning of this year, 1965, Venus was a morning star, rising about two hours before the sun. Each day it used to rise a little later. In February, it was rising only about an hour before the sun. As seen in the sky, the seeming distance between Venus and the sun, became shorter each day. In March, Venus was rising so short a time before the sun that dawn had already come before it rose. On April 11th, it was rising about the same time as the sun, it was behind the sun, at the far side of the sun from us. After that, it passed to the left hand side of the sun, rising after the sun, and setting in the west after sunset. It thus

became an evening star. At present, it is not very far to the left of the sun. Soon after sunset we can see it in the western sky, and then it sets. But, from now on, until November 15th, it will be setting later and later; as seen in the sky it will be getting further and further away from the sun. After November 15th it will cease to get further away, and start getting closer and closer, and setting earlier and earlier until January 26th, when it will be setting about the same time as the sun. It will then be between us and the sun. After that, it will pass to the right hand side of the sun and become a morning star again.

It was the Greeks who realized that the Morning Star and the Evening Star were the same planet. To explain its wanderings and the wanderings of the other planets, they thought up what developed into the Ptolemaic theory, that the Sun and planets all revolve about the earth in eccentric orbits, each with epicycles of its own.

Not until the 16th century did Copernicus show that the wanderings of the Planets could be more simply explained by supposing that they, and the earth, circled around the sun. Copernicus' plan was not quite accurate. Kepler showed that it was in ellipses, not in circles, that the Planets must move, if their wanderings were to be explained.

Kepler's discovery was based on the observations of Brahé, who was the last eminent astronomer to die before the invention of the telescope. Brahé had better instruments than any man before him ever had. With them, he measured the positions of the stars

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relative to one another. For thirty years he worked, fired with the ambition to prepare a complete and accurate catalogue of the stars. He would list every star in the heavens visible from his observatory. His observational work was completed, but his cataloguing was not completed, when he died.

Kepler, Brahé's successor as Imperial Mathematician, undertook to prepare Brahé's catalogue for publication. It was not until the year 1605 that the long-awaited catalogue was off the press. It proved to be a boon to astronomers, some of whom felt as though they now had the world by the tail. ..... Four years later, Galileo turned a telescope to the sky, and discovered that there were more stars in the firmament than man had ever dreamed of.

If we believe that our Father in heaven is gently educating us, then we might say that Lesson One, in Astronomy, ended with Brahé's catalogue. Lesson Two commenced with the telescope.

For the past three hundred and fifty years, the history of astronomy has been, largely, the story of the building of bigger and better telescopes. But, meanwhile, there has come other assistances to the astronomer. Photography has proved to be a greater aid to astronomy than had been anticipated. In its early days, attempts were made to find the exposure necessary to give us the best photographs of the stars, as we saw them through the

telescope. Inevitably, some photos were over exposed. On these there were found extra stars, not seen when looking through the telescope. Stars too faint to be seen by the human eye, even through the telescope, with long exposure, make their imprint on the photographic film. To-day, it is common practice to search for faint objects by long exposure. Some of the most beautiful photographs of nebulae, and distant objects, which you have seen, have never been seen with as much detail as shown in the photos.

Besides the camera, another instrument which has proved useful to the astronomer, is the spectroscope. It has enabled us to discover not only what elements are in the body of a star, giving bright lines on its spectrum, but also what elements are in its atmosphere, giving dark lines.

Practice led to progress, but so also did theory. At times, theory ran ahead of practice. Early in this present century, our theory of the nature of the atom told us that its particles, such as electrons and protons, must needs be held together by enormous forces. If we could split the atom, we could release enormous power. This theory was all that the astronomer needed to forge ahead. We had been unable to account for the enormous energy of the sun and other stars. Now we had an adequate explanation. Between 1918 and 1939, astronomers worked out in detail the processes of nuclear energy. They had found out that stellar energy could be explained by what we now call a chain reaction of nuclear

explosions. Furthermore, as early as 1931, it was estimated that to create the universe, it would be sufficient for the Creator of all things to create only one great mass, contracting all the time until it set off a supercollosal explosion, which would send the matter of all the stars and galaxies flying through space to form the Universe.

According to the 'big-bang' theory of the origin of the Universe, there would be, in 1931, some galaxies so far away that they would be out of range of the biggest telescope, which was, in 1931, the 100-inch mirror on Mount Wilson. The need for a larger telescope became urgent. The 200-inch was designed for Palomar. It was designed to see stars and galaxies as faint as the 24th magnitude. It has never seen such faint stars or galaxies. Objects just a little brighter, objects of the twenty-third-and-a-half magnitude, have been photographed with long exposure. Longer exposure, with the 200-inch, gives only a better picture of the general background, a picture of starlight. So it was discovered that the light of all the stars together, when seen through our atmosphere, appears as bright as a 24th magnitude star. We could no more hope to photograph a 24th magnitude star, when the stars are shining, than we could hope to photograph the stars when the sun in shining. The astronomers at Palomar were desolate. Not even bigger telescopes could solve their problem. It seemed that we could never hope to see the faintest stars.

It was time for Lesson Three. Before the Second World War, a radio engineer, looking for the causes of static, traced some sources to the sky. In 1933, he wrote a paper entitled: "Radio Waves from Outside our Solar System". It was published in a journal for radio engineers. Few astronomers saw the article. Fewer read it. None of those who read it, thought of static as having anything to do with astronomy.

During the Second World War, radar came into use. To detect the presence of enemy planes was all important. Radar was plagued with extra-terrestrial noises. During the war, it was necessary not to confuse these noises with anything due to any contrivance of the enemy. The High Command deemed this sufficient. To investigate the sources of these noises was deemed unnecessary.

Among the technical personnel in the Services were graduate physicists and astronomers itching to do some research on the noises. Many of them, quite independently, decided that what they would do after the war was investigate the sources of these extra-terrestrial radiations. Most of them lived up to their resolve. In Britain, in Canada, and in Australia, ex-service men acquired from War Surplus large radio antennae. Thus the science of Radio Astronomy was born. Its promises were great. With bigger and bigger antennae, the radio telescope could penetrate deeper into space than the optical telescope.

Many of the radio sources so far discovered have been identified. Some of them are distant galaxies, others, interstellar clouds, others

the remnants of exploded stars. Most of the radio sources, however, are still just positions in the firmament, where the optical telescope sees nothing.

The possibility of any of the unidentified sources being ordinary single stars was, after a few years experience, ruled out. We do receive radiation on radio wavelengths from the sun (which is a star), but the reception from the sun is so weak that if the sun was moved away to the distance of the next nearest star we could not receive it radiation with our present antenne.

However, about four years ago, a radio source was discovered which seemed to coincide with the position of a star. There was some uncertainty, because a radio telescope cannot pin-point sources with the same accuracy as optical telescopes can pin-point a source of light. Also, the radio telescope could not tell the distance of the source. It might be behind the star. The 200-inch telescope was used to photograph the star which seemed to be a radio source. It verified the fact that the centre of the source seemed to be a star, but it found some nebulous matter associated with the star. A spectrogram was taken. The spectrum was full of surprises. It was not like the spectrum of any other star. Also, it indicated that the object was flying away from us with tremendous speed, with the speed of the most distant galaxies known. Other radio sources which seemed to have stars as their centres were investigated. The results were similar. They are all very far away.

One of them is further away than any known galaxy. The others appear brighter than equally distant galaxies.

The more commonly accepted interpretation of these new stellar objects is that they are larger galaxies than we knew existed, that they are so far away we cannot detect their galatic structure, and so large, that their galatic nuclei, at this distance, appear to us ~~are~~ as bright as a nearby star. How a galaxy can have a nucleus as to appear so bright at so great a distance of so great energy is still debated. But the existence of the objects opens up new vistas. For years, we have taken for granted that the fainter galaxies were further away than the brighter ones. Now it seems that this is not always so. Some of the more distant quasi-stellar objects are brighter than nearer ones.

Astronomers are excited, and filled with wonder. In a deeper sense than ever before, THE HEAVENS DECLARE to astronomers THE GLORY OF GOD, AND THE FIRMAMENT of stars PROCLAIMS THE WORK OF HIS HANDS.

David was impressed by the panorama of the stars at night. The sight of the stars on a moonless night is fascinating. Study of their operations and evolutions does not detract from our wonder, it adds to it. Knowledge deepens our appreciation of God's majesty and power and intelligence.

In December 1963, an international symposium was held to discuss the new stellar objects. The physics of the objects posed problems. No one of the proferred solutions was unanimously accepted.

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The most plausible explanation offered was that we are now seeing, in the nuclei of very distant galaxies, a chain reaction of explosions which occurred from one to three thousand million years ago. When no agreement was reached, the chairman, J. Robert Oppenheimer, in his summation, said: "At least, these objects are the record of unprecedented events of great splendor and wondrous beauty". To me, and to many, Oppenheimer's words were but a twentieth century American echo of the words of David of Bethlehem: THE HEAVENS DECLARE THE GLORY OF GOD, AND THE FIRMAMENT PROCLAIMS THE WORK OF HIS HANDS.

Lesson four in astronomy will begin when we get a telescope to the moon and see the stars and distant galaxies, undimmed by the 10 miles of molecular atmosphere through which we look at them from earth.

Then, astronomers will not only have their minds raised to heaven, but they will look forward to seeing God in heaven.

We will then better understand and appreciate St. Paul's words about the difference between here and heaven: WE NOW SEE THROUGH A GLASS, DARKLY, BUT THEN, FACE TO FACE (I Cor. 13,12).