The universe is getting out of breath

A new study of more than 200,000 galaxies, from the ultraviolet to the far infrared, has provided the most comprehensive assessment of the energy output of the nearby universe. It confirms that the production of stars by galaxies today is only about half what it was two thousand million years ago. This overall “fading” reflects a decrease in the rate of star formation via the collapse of cool clouds of gas. It seems that the universe is running out of gas – in effect, getting out of breath – and slowly dying.

It is well known to astronomers that the rate at which stars form in the universe reached a peak around a redshift $z=2$ when the universe was about 3 Gyr old. Over the subsequent 3 Gyr until now, the production of stars in galaxies has steadily decreased in a given co-moving volume of space – that is, a volume expanding at the same rate as the cosmic expansion of the universe, therefore keeping a constant matter content during the history of the universe. Because the most massive stars are also the most luminous ones and have the shortest lifetimes, the energy output of a galaxy is closely related to its star-formation rate. Indeed, some 100 million years after the formation of a star cluster, its brightest stars would have exploded as supernovas leaving only the lower-mass stars, which are much less luminous.

Although the fading trend of the universe has been known since the late 1990s, measuring it accurately has been a challenge. Part of the difficulty is to gather a representative sample of galaxies at different redshifts and to account properly for all biases. Another complication comes from the obscuration by dust in the galaxies, which absorbs ultraviolet and visible radiation and then re-emits this energy in the infrared. A way to overcome these difficulties is to observe the same region of the sky at many different wavelengths to cover fully the energy output. This has now been achieved by a large international collaboration led by Simon Driver from the International Centre for Radio Astronomy Research (ICRAR), University of Western Australia.

The study is part of the Galaxy and Mass Assembly (GAMA) project, the largest multi-wavelength survey ever put together. It used seven of the world’s most powerful telescopes to observe more than 200,000 galaxies, each measured at 21 wavelengths from the ultraviolet at 0.1 μm to the far infrared at 300 μm. Driver and collaborators then used this unique data set to derive the spectral energy distribution of the individual galaxies, and the combined one for three different ranges of redshift up to $z=0.20$. For the nearest galaxies, they obtain an average energy output of $(1.5\times10^{35})\times10^{-35}\text{W}$ produced on average by galaxies in a co-moving volume of a cubic megaparsec, which is equivalent to a cube with a side of about 3.3 million light-years. While this is for a redshift range between $z=0.02$ and $z=0.08$, corresponding to a mean look-back time of 0.75 Gyr, the team finds a significantly higher value of $(2.5\times10^{35})\times10^{-35}\text{W}$ for a look-back time of 2.25 Gyr (0.14 c<z<0.20). This indicates a decrease by about $10^{-2}$ in 1.5 Gyr. This trend occurs across all wavelengths and corresponds roughly to a decrease by a factor two over the past two thousand million years.

The ongoing decay of energy production by stars in galaxies also follows the trend of active galactic nuclei and gamma-ray bursts, which were all more numerous and powerful several gigayears ago. The shining, glorious days of the universe are now long past; instead, it will continue to decline, sliding gently into old age, an age of quietness.

Further reading
CERN Computing and Data Processing School

After the success of the Varenna School in 1970, a second CERN Computing and Data Processing School was organized from 10–23 September at Pfortsiva on the shore of the Achensee, an alpine lake in the Austrian Tyrol.

The school brought together a cosmopolitan group of young people working in scientific data processing, to exchange opinions and discuss problems stimulated by experienced lecturers from Western Europe and CERN. The 67 students came from CERN member states, the German Democratic Republic, Israel, Poland, the USSR and Yugoslavia.

Disp. topics were divided between pure computer science, applications of small computers in physics, and applied mathematical techniques.

A significant fact to emerge was that the computers are widely used for this and standardization is playing an essential role to allow physicists to talk to the equipment in a very simple way, mainly using CAMAC and CAMAC-oriented software.

Another important topic is data communication between scientists working in different laboratories using different hardware and software. A European network of fast data links is technically feasible, but difficulties arise in exchanging information among machines that use different operating systems. The importance of establishing standards for information exchange was emphasized during one of the informal discussions organized by the students themselves.

Compiled from texts on pp326–327.

CERN Public Information Office

From its early days, CERN has had a “public information office”, the PIO, the communication channel to the outside world and for many internal-communication tasks. PIO staff are well known to top-class journalists from almost all the member states. Also, many television teams and radio interviewers invade CERN each year, and the PIO either covers their needs or guides them to appropriate CERN contacts.

On the film front, the first CERN documentary, Matter in Question, appeared in 1961, and is still in limited use although now largely outdated.

In recent years, several collaborative films have been made with national television networks, the latest being with the BBC (CERN Courier September 2015 p11).

The PIO produces a range of publications, from the pop to the not-so-pop. The mandatory Annual Report, in English and French, is the account of CERN’s activities in the previous year. Regular publications are the Weekly Bulletin and the monthly CERN Courier: Documentation for visitors ranges from the light-hearted “A look at CERN” through to the more formal “CERN and its Laboratories”.

The photo section takes about 8000 photos per year and also some cine film, for example the assembly of the large European bubble chamber BEBC. Important stages of other large projects have been recorded on 16 mm film for archival records.

Another major activity is the visits service. Visitors are held mostly in French, German or English. About 50 CERN staff, covering many nationalities, act as guides and lecturers. The current annual visitor figure is about 11,000 (excluding Open Days).

Two-thirds come on Saturdays, mainly school parties and common-interest groups (farmers, nurses, firms’ outings). Midweek visitors are mostly university groups, industrialists from firms working for CERN, and occasional scientists in transit. VIPs obviously receive special attention.

Compiled from texts on pp327–329.

CERN Computing and Data Processing School

At the 1972 CERN Computing and Data Processing School, data-handling and control requirements of high-energy physics are becoming so demanding as to require computer applications of greatly increased complexity.

Nowadays, experiments use sophisticated equipment and it is essential to monitor the performance of the apparatus. Small

CERN and its surroundings now have considerable international interest. Regular publications are the Mandatory Annual Report, in English and French, and also a number of other publications, including the Monthly CERN Courier: Documentation for visitors ranges from the light-hearted “A look at CERN” through to the more formal “CERN and its Laboratories”.

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