2.1.1 Annual highlights 2021

Galaxies ran out of gas

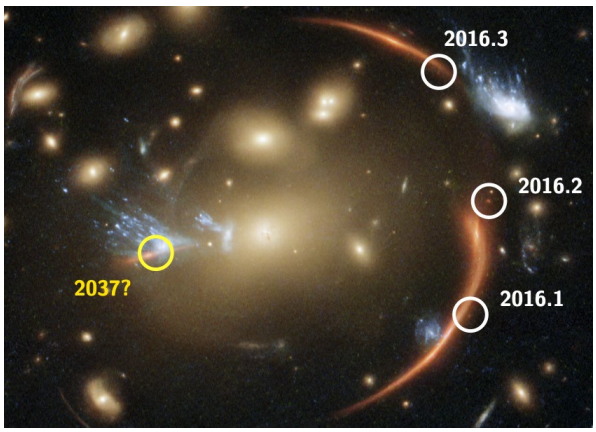
One of the great questions in astronomy is how some galaxies, after having spawned billions of stars at a continuous rate, suddenly cease to form new stars. Since stars are made of gas, we expect the reason for this *quenching* to somehow be associated with the galaxies' gas supply being exhausted. In the present-day Universe, where galaxies have had billions of years to slowly use up their gas, this is perhaps less puzzling. But until recently it had not been confirmed observationally in the early Universe, where galaxies have had much less time to evolve.

We were therefore excited to report the detection of a small sample of galaxies, seen as far back in time as 10–12 billion years ago, which are clearly seen to have run out of gas. The study, led by Kate Whitaker and published in Nature, specifically targeted galaxies lying behind massive galaxy clusters, the immense gravity of which helps magnify their light.

What physical processes led to the depletion of gas is still unknown. But with the recent successful launch of the James Webb Space Telescope, we are optimistic that follow-up observations will reveal the cause for the early quenching of galaxies.

Supernova déjà vu

One of the galaxies from Whitaker's study is seen in the figure on the right as a huge, red arc circumscribing a foreground cluster. The odd shape arises because the light from the galaxy follows different paths around the cluster. While co-authors Gabriel Brammer and Sune Toft were inspecting the image, taken with the Hubble Space Telescope in 2016, they noticed a little red dot. Curiously, the dot was missing from images of the same field, taken three years later.



A massive galaxy cluster acting as a gravitational lens paved the way for two astonishing results in 2021: First, the light from a distant background galaxy is magnified to huge, red arcs, allowing us to study it in great detail and conclude that it ran out of gas. Second, because the light follows different paths around the cluster, we were able to predict that a supernova, seen three different places in 2016, will reappear in a fourth place in 2037.

The dot — or *dots*, because it is seen in three different places on the sky due to the lensing effect — turned out to be a *supernova*; the death explosion of a star that ended its life over 10 billion years ago. With a physical model of the gravitational field of the galaxy cluster, they were able to make a remarkable prediction, published in Nature Astronomy:

In addition to the three images appearing in 2016, the light should also take on a fourth and slightly longer path, resulting in the reappearance of the supernova in 2037. More than just a curiosity, the exact delay — observed with upcoming facilities such as the 39 meter European Extremely Large Telescope — will enable us to accurately measure the expansion rate of the Universe.

Årets højdepunkter 2021

Galakser løb tør for gas

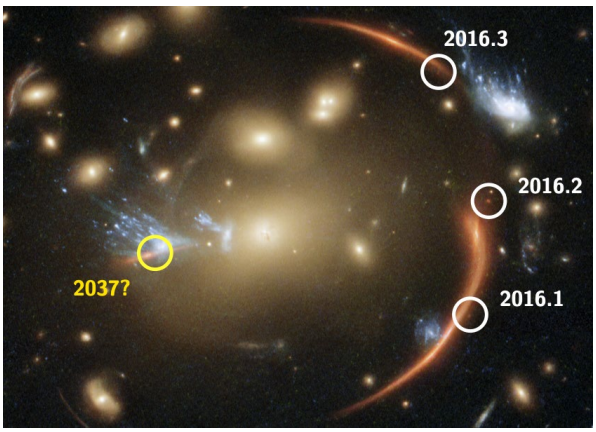
Et af astronomiens store spørgsmål er, hvordan nogle galakser, efter med jævn hastighed at have skabt milliarder af stjerner, pludselig holder op med at danne nye stjerner. Fordi stjerner er lavet af gas, forestiller vi os at årsagen til denne "kvælning" hænger sammen med, at galakserne bruger deres gasforsyning op. Nutildags, hvor galakser har haft milliarder af år til langsomt at opbruge deres gas, virker dette måske meget rimeligt. Men indtil for nylig var det ikke blevet bekræftet observationelt i det tidlige Univers, hvor galakser har haft meget mindre tid til at udvikle sig.

Vi var derfor glade for at kunne rapportere opdagelsen af en lille flok galakser, set så langt tilbage i tiden som for 10–12 milliarder år siden, der helt tydeligt er løbet tør for gas. Undersøgelsen, ledet af Kate Whitaker og publiceret i Nature, var specifikt rettet mod galakser, der ligger bag tunge galaksehobe, hvis enorme tyngdekraft hjælper med at forstørre deres lys.

Hvilke fysiske processer, der førte til denne dræning af gas, ved vi endnu ikke. Men med den nylige succesfulde opsendelse af rumteleskopet James Webb er vi fulde af forventninger om, at opfølgende observationer vil afsløre årsagen til den tidlige kvælning af galakser.

Supernova-deja-vu

En af galakserne fra Whitakers studie ses på figuren til højre som en enorm, rød bue, der omkranser en hob af galakser, som ligger i forgrunden. Denne mærkelige udformning opstår, fordi lyset fra baggrundsgalaksen følger forskellige ruter rundt om hoben. Da medforfatterne Gabriel Brammer og Sune Toft undersøgte billedet, taget med rumteleskopet Hubble i 2016, bemærkede de en lille rød prik. Mærkeligt nok manglede prikken på billeder af det samme felt, taget tre år senere.



En tung galaksehob, der fungerer som en tyngdelinse, banede vejen for to bemærkelsesværdige resultater i 2021: For det første bliver lyset fra en fjern baggrunds-galakse forstørret til enorme, røde buer, hvilket giver os mulighed for at studere den i høj detalje og konkludere, at den løb tør for gas. For det andet, fordi lyset rejser forskellige veje rundt om hoben, var vi i stand til at forudsige genkomsten af en supernova i 2037.

Prikken — eller rettere *prikkerne*, fordi den ses tre forskellige steder på himlen på grund af linseeffekten — viste sig at være en supernova; eksplosionen af en stjerne, der endte sit liv for over 10 milliarder år siden. Med en fysisk model af galaksehobens tyngdefelt var de i stand til at bringe en opsigtsvækkende forudsigelse, publiceret i Nature Astronomy:

Ud over de tre billeder der dukkede op i 2016, burde lyset også tage en fjerde og lidt længere vej, hvilket resulterer i at supernovaen dukker op igen i 2037. Mere end blot et kuriosum, vil den præcise forsinkelse gøre os i stand til nøjagtigt at måle Universets udvidelseshastighed.