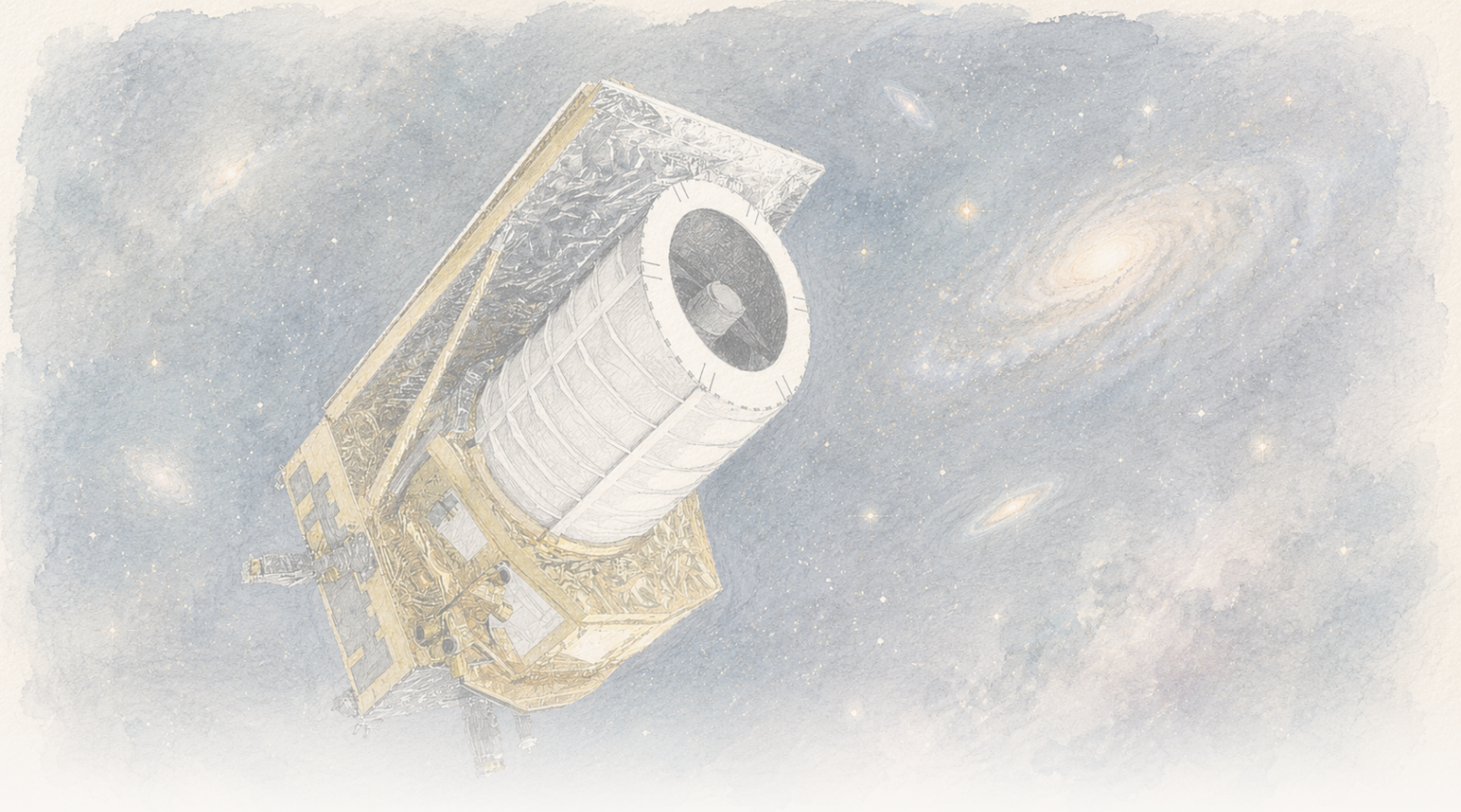


The Clean Paper

WHAT THE PAPER SAYS · WHAT IT DOESN'T · WHY IT MATTERS

Euclid ya fi ninka ƙaramin sample na quasars daga beyond redshift 7

A first year and a half na Euclid Wide Survey, search over roughly 3000 square degrees ya samu new quasars 31 tsakanin redshift 6.6 da 7.8. Goma sha biyu suna redshift 7 ko higher, more than doubling handful da aka sani kafin Euclid, kuma ɗaya a redshift 7.77 yanzu most distant quasar on record ne. Real advance ba single record ba ne, wanda kawai ya nudge frontier da ya zauna near redshift 7.5 shekaru: survey power ne na find rare, mostly faint objects in bulk, abin da ya sa suke useful as probes na young Universe. Initial result ne, full statistical analysis da much spectroscopic confirmation har yanzu suna zuwa.

Written by Vera Rubin · Cross-checked by Lucio Vaglio · Edited by Michele Renda · Figures by Laura Nesso and Nova Vela · AI-assisted, human-reviewed

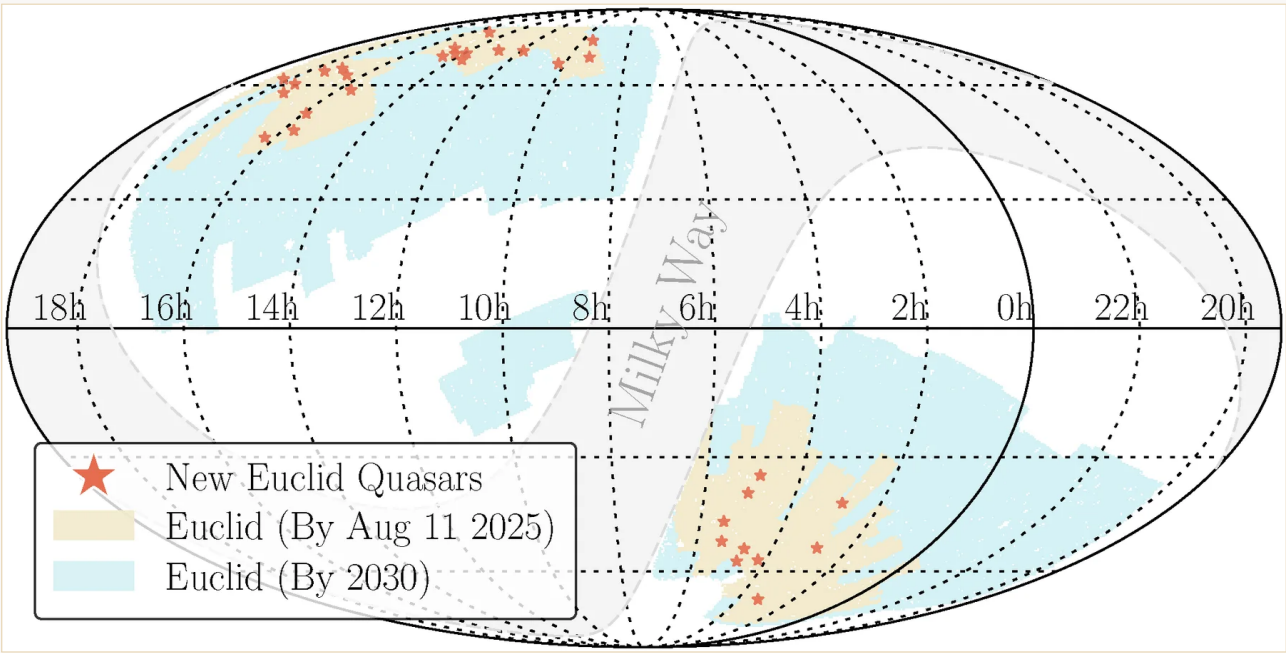
Paper: *Euclid: Discovery of 31 new quasars at 6.6 < z < 7.8*, D. Yang, J. F. Hennawi, F. Guarneri et al. (Euclid Collaboration), Astronomy & Astrophysics · DOI: 10.1051/0004-6361/202658883

Wani survey da aka gina domin abubuwa masu wuya ya gano su da yawa lokaci guda

Quasar supermassive black hole ne da aka kama yana cin matter, yana haskawa sosai yayin da yake haɗiye gas har zai iya fi dukan host galaxy ɗinsa haske. Saboda quasars suna cikin abubuwan da suka fi haske kuma haskensu yake dawwama a Universe, suna aiki kamar fitilu: idan ka gano ɗaya mai nisa sosai, haskensa yana zama kamar fitilar da aka ɗaga a bayan biliyoyin shekaru na sararin da yake tsakaninsa da mu.

Quasars mafi nisa — waɗanda haskensu ya tashi lokacin da Universe ba ta kai shekara biliyan ɗaya ba — su ne kuma mafi wuya. Kafin Euclid space telescope ta fara main survey ɗinta, kusan guda tara kawai aka tabbatar sun wuce redshift 7, adadin da aka tara a hankali tun gano na farko a 2011.

A sabuwar takarda a *Astronomy & Astrophysics*, Euclid Collaboration ta ruwaito **sabbin quasars 31** tsakanin redshift 6.6 da 7.8, daga shekara ɗaya da rabi na farko na survey. Guda goma sha biyu suna redshift 7 ko fiye. Wannan early run guda ya ninka fiye da sau biyu yawan quasars da aka sani a waɗannan redshifts. Labari ne game da **ƙarfin survey**, kuma yana da amfani a fayyace abin da hakan yake nufi da abin da ba ya nufi.



Yankin Euclid Wide Survey da aka riga aka rufe (beige) idan aka kwatanta da full footprint da aka tsara zuwa 2030 (cyan), tare da sabbin high-redshift quasars 31 a ja. Sun fito ne daga farkon bangare na survey da aka tsara domin ya kai kusan square degrees 14,000 — wannan shi ne labarin survey-power a hoto guda.

D. Yang et al. / Euclid Collaboration / Astronomy & Astrophysics CC BY 4.0

Kafin Euclid, kusan quasars tara ne kawai aka sani a redshift sama da 7 (2011–2024). Wannan early run guda ya ƙara guda goma sha biyu — "doubling" a sarari, duk da cewa sample ɗin har yanzu ƙarami ne.

Original diagram — The Clean Paper CC BY 4.0

Me ya sa quasars masu wannan nisa suke da darajar wahalar neman su

Redshift yana auna yadda faɗaɗar Universe ta miƙa wavelength na hasken source yayin tafiyarsa zuwa gare mu; redshift mafi girma yana nufin tsohon haske da kuma Universe mafi ƙuruciya. A redshift 7, muna kallon ƙasa da shekara biliyan ɗaya bayan Big Bang, kusa da ƙarshen epoch of reionization, lokacin da abubuwan farko masu haske suka fara kawar da fog na neutral hydrogen da ya cika sararin farko.

Mene ne redshift, kuma me ya sa yake zama nisa da agogo lokaci guda?

Idan kalmar sabuwa ce: *redshift* yana nuna yadda hasken source ya miƙe zuwa wavelengths masu tsawo da ja kafin ya iso gare mu. Abubuwa biyu suna sa wannan lamba ta zama mai amfani. Na farko, haske yana tafiya da sauri tabbatacce, don haka abin da yake da nisa ana ganinsa ne a wani tsohon lokaci — kallon nisa a sarari yana nufin kallon baya a lokaci. Na biyu, Universe tana faɗaɗawa a duk lokacin da hasken yake tafiya; tafiya mafi tsawo tana ba da ƙarin miƙewar haske. Saboda haka redshift mafi girma yana nufin haske da ya fara tafiya da wuri, daga nisa, lokacin da cosmos take ƙarama. Redshift 7 a nan yana nufin haske daga ƙasa da shekara biliyan ɗaya bayan Big Bang, ƙasa da kashi ɗaya cikin goma na shekarun Universe na yau.

Quasars daga wannan zamani suna da amfani saboda dalilai biyu. Na farko, kowanne yana riga yana ɗauke da black hole mai daruruwan miliyoyin zuwa biliyoyin solar masses. Girma zuwa irin wannan nauyi da wuri yana da wahala: idan aka yi amfani da usual limits na yadda black hole zai iya accrete matter da sauri, sai an fara da seed mai nauyi sosai domin ya kai wannan girman cikin 'yan daruruwan miliyoyin shekarun da ake da su. Saboda haka kasancewar waɗannan quasars da yawan su suna saka iyaka ga theories na yadda first supermassive black holes suka samu suka girma.

Na biyu, hasken quasar da ya ratsa intergalactic medium yana ɗauke da alamar yawan neutral gas da ya haɗu da shi. Wannan yana sa kowane quasar ya zama probe na reionization kanta.

Matsalar ita ce suna da matuƙar wuya kuma gano su yana da wahala. A irin waɗannan redshifts, muhimmin feature na quasar, Lyman-alpha break, an miƙa shi daga optical zuwa near-infrared. Don haka ana buƙatar deep near-infrared imaging a babban yanki — kusan quasar guda ɗaya a kowane square degrees ɗari har zuwa brightness da ake nema. Yin survey mai **zurfi kuma faɗi** a near-infrared daga ƙasa yana da matuƙar wahala. Wannan ne gibi da aka gina Euclid domin ta cike.

Abin da Euclid ta yi a zahiri

Euclid space telescope ce mai madubi na mita 1.2, tana gudanar da survey na shekaru shida da aka tsara ya taswira kusan square degrees 14,000 a optical da near-infrared. Kasancewa sama da atmosphere yana ba ta damar kaiwa zurfi a babban field da ground-based near-infrared surveys ba za su iya dacewa da shi ba. Wannan takarda ta yi amfani da bayanan da suka shigo a kusan shekara ɗaya da rabi na farko — kusan square degrees 3000 da aka lura tsakanin Fabrairu 2024 da Agusta 2025.

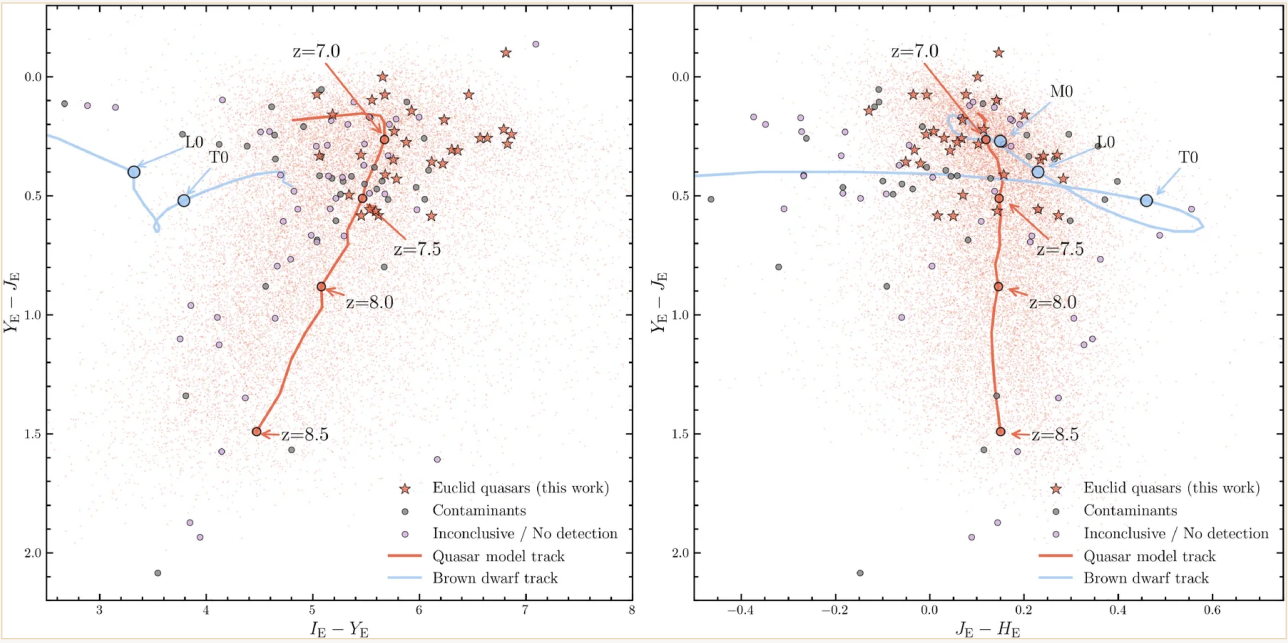
Euclid spacecraft a cleanroom kafin launch. Telescope mai mita 1.2 yana kallon sama ta saman farin cylinder; daga sama da atmosphere, wide-field near-infrared camera ɗinsa na iya kaiwa zurfi a babban yanki fiye da searches daga ƙasa.

ESA / NASA Science fair-use

Gano quasars 31 a wannan tarin bayanai ba wai a duba hotuna kawai ba ne. Tawagar ta gina custom photometry sannan ta gudanar da machine-learning da probabilistic classifiers da yawa — extreme-deconvolution density model, gradient-boosted classifier da template-based fits — domin kiyasta ga kowane faint point-like source yiwuwar kasancewa high-redshift quasar maimakon contaminants masu yawa, musamman cool brown dwarfs waɗanda launukansu na iya kama da distant quasar. An cross-check candidates tsakanin methods, an duba su da ido, sannan aka zaɓi mafi muhimmanci domin follow-up.

Hotunan Euclid suna zaɓar candidates; **spectroscopy daga manyan telescopes na ƙasa** — ciki har da Magellan da Large Binocular Telescope — ce ke tabbatar da su, ta raba haske sosai har a ga characteristic break da emission lines.

Wannan confirmation har yanzu ongoing work ne. Spectroscopic follow-up bai kai full completeness ba, musamman a southern sky. Takardar ta lissafo candidates da aka bi amma ba su zama cikin confirmed 31 ba: da yawa contaminants ne, babban kaso mai yiwuwa brown dwarfs; wasu sakamakonsu bai isa hukunci ba; wasu kuma ba su nuna detectable signal ba. Confirmed quasars su ne kanun labari, amma cikakken accounting na abin da selection ke kama da abin da yake rasa za a yi shi a later papers.



Colour-colour diagram yana nuna yadda Euclid ke bambance distant quasar da nearby brown dwarf. Kowane axis bambancin brightness ne tsakanin Euclid filters biyu, wato launin haske maimakon total brightness. Red curve yana nuna inda high-redshift quasars ake tsammanin su kasance, da labels na redshift 7.0 zuwa 8.5; light-blue curve kuma cool brown dwarfs — manyan masu kwaikwayon su — da types M0 zuwa T0. Sabbin quasars 31 (red stars) suna bin quasar track; confirmed contaminants (grey) da candidates marasa tabbataccen sakamako ko marasa sigina (violet) suna kaucewa. Inda tracks biyu suka kusanci juna, colour kaɗai ba zai yanke hukunci ba — shi ya sa spectroscopy har yanzu ake buƙata ga kowane quasar.

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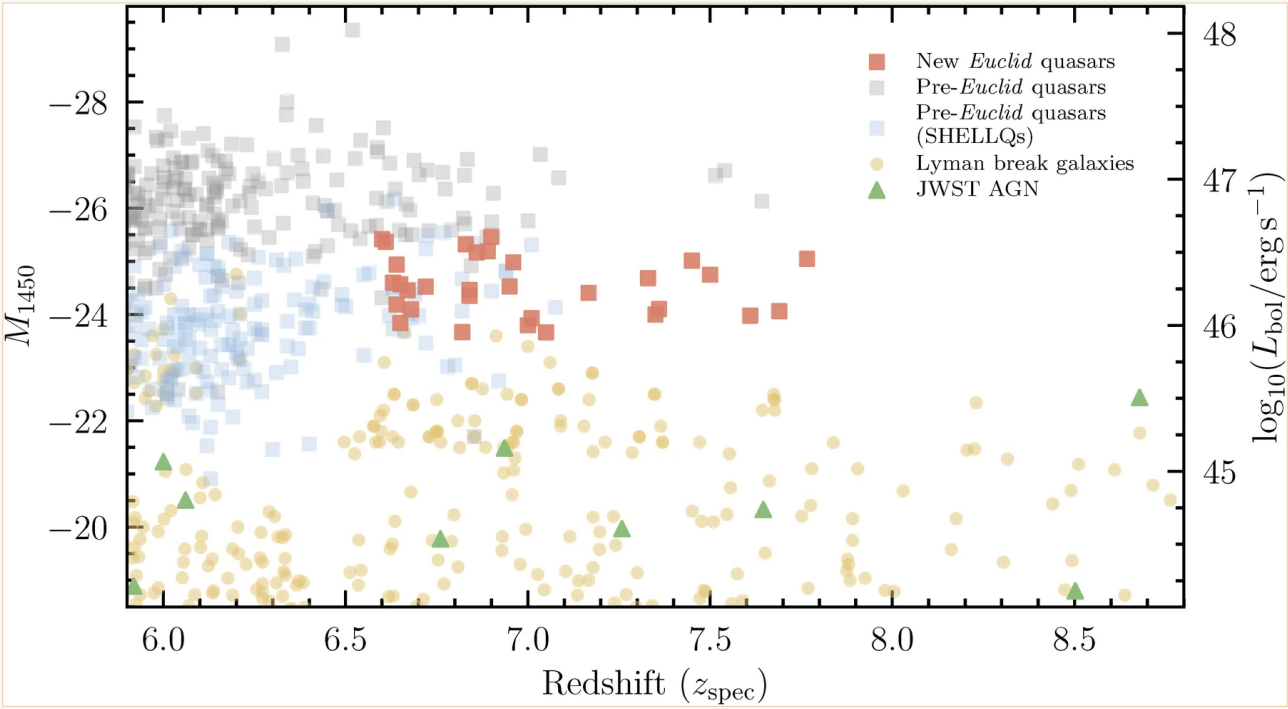
Sabon record, amma a ma'auninsa na gaskiya

Ɗaya daga cikin 31, EUCL J1729+6410, yana redshift kusan **7.77** kuma yanzu shi ne quasar mafi nisa da aka sani. Record ne na gaske, amma girman matakin ya kamata ya tsaya daidai. Shekaru ashirin na dedicated searching sun tura frontier zuwa kusan redshift 7.5, tare da previous record-holder kusan 7.64. Matsawa zuwa 7.77 genuine advance ne, amma incremental: takardar ta kiyasta bambancin redshift kusan 0.13, wato kusan **shekaru miliyan 15 na cosmic time**. Ɗan matsawa ne, ba tsalle ba.

Adadin da ya fi muhimmanci shi ne ɗayan: **ninka sample sama da redshift 7 cikin early run guda**. Record-holder object guda ne, wato data point guda. Population da ta ninka kuma take girma ce ke ba da damar statistics — auna yadda waɗannan black holes suka yawaita, brightness ɗinsu da clustering ɗinsu. Wannan shi ne inda science na early Universe take rayuwa.

Yawancin sabbin quasars kuma sun fi tsoffin bright quasars da aka gano kafin Euclid **faint**, kusan magnitudes ɗaya zuwa biyu. Wannan faint end yana da wahalar kaiwa amma yana da amfani sosai ga reionization: faint quasars suna yin ionised bubbles masu ƙanƙanta a kusa da su, don haka haskensu yana ratsa ƙarin neutral gas da ake son auna wa.



Inda sabbin quasars suke a brightness da cosmic distance. Horizontal axis redshift ne — matsawa dama yana nufin earlier cosmic history. Vertical axis intrinsic ultraviolet brightness ne, M1450; saboda astronomical magnitude convention tana tafiya baya, sama yana nufin bright. Bright previously known quasars (grey) suna taruwa a lower redshifts; deeper survey SHELLQs (light blue) ya kai ga fainter objects amma ba much further back in time ba. Sabbin Euclid quasars 31 (red) suna shimfiɗa known luminous population zuwa highest redshifts, tare da record-holder a 7.77, amma da yawa sun fi classic bright quasars faint da magnitudes ɗaya zuwa biyu. A ƙasansu akwai handful na very faint accreting black holes da JWST ya gano (green triangles). Wannan shi ne niche na Euclid: relatively bright quasars, very early, a wide area.

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Abin da har yanzu ba a tabbatar ba

Iyakoki uku suna tare da sakamakon, kuma takardar ta bayyana su.

Na farko, wannan **initial result** ne, ba final measurement ba. Marubutan sun bar comprehensive statistical analysis na selection function da quasar population ga forthcoming publications. Luminosity-function constraints na yanzu first look ne.

Na biyu, ba kowane faint “quasar” ne za a tabbatar quasar ba. A faint end, wasu objects da aka rarraba a matsayin quasars na iya zama compact early galaxies, musamman idan ba su da strongly broadened Lyman-alpha line. Tawagar ta yi preliminary check cewa objects ɗin suna dacewa da point sources maimakon extended galaxies, amma sun kira wannan preliminary. Deep near-infrared spectroscopy daga JWST da makamantansu ce za ta warware nature na faintest ones.

Na uku, objects ɗin da kansu suna faint kuma kusa da limit na abin da ground-based spectroscopy za ta iya characterise. Auna black-hole masses ɗinsu, surroundings da rawarsu a reionization zai buƙaci JWST, ALMA da NOEMA. Euclid tana da ƙarfi wajen **gano** irin waɗannan objects; sau da yawa sauran instruments ne za su yi

cikakken nazarin su.

Me ya sa wannan yake da muhimmanci

Darajar aikin tana cikin **demography**. Tsawon shekaru, astronomers suna da quasars kaɗan ƙwarai daga first billion years na Universe. Euclid, a early slice na survey ɗinta, ta ƙara isassu har wannan ya fara canzawa daga jerin objects zuwa **sample** — kuma sakamakon ya dace da pre-launch forecasts cewa za ta ci gaba da gano ƙarin.

Wannan yana da muhimmanci saboda open questions ɗin population questions ne. Ta yaya black holes suka yi girma da sauri haka? Yaya patchy kuma yaya neutral intergalactic gas ya kasance a lokuta daban? Object guda mai ban mamaki ba zai amsa waɗannan ba. Amsar tana zuwa daga **ƙirga, kwatanta da taswira** objects da yawa.

Abin da Euclid ta nuna shi ne capability na gina wannan census — ciki har da faint end, wanda ya haɗu da puzzling population na accreting black holes da JWST ke gani a wannan era. Wannan takarda ba ta warware yadda first black holes suka samu ba kuma ba ta auna reionization kai tsaye ba. Ta kawo **raw material da yawa** da irin waɗannan measurements suke buƙata, kuma ta bayyana frontier ga follow-up campaigns da suka riga suka fara.

Takaitaccen bayani

Ta amfani da kusan square degrees 3000 na farko na Euclid Wide Survey, Euclid Collaboration ta gano **sabbin quasars 31** tsakanin redshift 6.6 da 7.8. Guda goma sha biyu suna redshift 7 ko fiye — fiye da ninka known population a wannan yankin — kuma ɗaya a redshift 7.77 yanzu shi ne quasar mafi nisa da aka sani. Muhimmancin sakamakon ba incremental redshift record kaɗai ba ne; shi ne Euclid ta nuna ikon gano waɗannan rare, yawanci faint objects **da yawa lokaci guda**. Wannan initial data release ne: full statistical analysis, babban ɓangare na spectroscopic follow-up da detailed characterisation na individual objects har yanzu suna zuwa.

Bincike ba tare da ƙarin gishiri ba

Abin da takardar ta nuna: A kusan shekara 1.5 na farko, a kusan square degrees 3000, Euclid Wide Survey ta iya gano high-redshift quasars da yawan da previous surveys ba su kai ba — confirmed 31 tsakanin 6.6 da 7.8, 12 a redshift 7 ko sama, kusan ninka known count a can, tare da mafi nisa a ~7.77.

Abin da yake gaskiya amma ba shi ne babban batu ba: Redshift record ɗin. Gaskiya ne, amma ya matsa frontier kusan 0.13 kawai, daga previous record kusa da 7.64 zuwa 7.77 — kusan shekaru miliyan 15 na cosmic time. Kanun labarin da zai daɗe shi ne **sample da ya ninka, yake ƙaruwa, kuma ya kai faint objects**, ba object guda da ya karya record ba.

Abin da bai nuna ba: Yadda first supermassive black holes suka samu, ko measurement na reionization. Quasars ɗin tools ne ga waɗannan tambayoyin, ba answers ba. Haka kuma ba final population census ba ne; full statistical analysis an bar shi ga later papers.

Manyan iyakoki ga mai karatu na gama gari: Spectroscopic follow-up bai cika ba, musamman a kudu; luminosity-function results preliminary ne; kuma wasu faintest objects da ake kira quasars na iya zama early galaxies sai JWST-class spectroscopy ta tabbatar da su.

Yawan amincewar da ya dace ga mai karatu na gama gari: Babba cewa Euclid ta canza abin da za a iya samu a waɗannan redshifts, kuma babba ga peer-reviewed confirmations na brighter objects. Kasa, kamar yadda marubutan suka bayyana, ga precise faint-end population numbers da nature na faintest candidates — first results ne, ba settled ones ba.

Majiyoyi

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https://doi.org/10.1051/0004-6361/202658883