

Two Peas in a Pod: The First Confirmed Dual Active Galactic Nucleus within a Green Pea Galaxy System

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Abstract

The growth of galaxies in the early Universe is thought to be dominated by compact, intensely star-forming systems, yet the corresponding growth of supermassive black holes (SMBHs) within such environments remains poorly constrained. Green Pea galaxies are nearby analogs of rapidly assembling galaxies in the early Universe owing to their compact morphologies, intense star formation, low metallicities, and extreme ionization conditions. Although galaxy interactions are thought to trigger episodes of rapid SMBH growth, direct observations of simultaneous accretion onto multiple SMBHs in compact, intensely star-forming galaxies are lacking. Here we report the discovery of the first confirmed dual active galactic nucleus (AGN) in a Green Pea system, SDSS J162209.41+352107.5. *Chandra* imaging resolves two luminous hard X-ray sources separated by 8.4 kpc in projection, demonstrating simultaneous accretion onto two SMBHs. Follow-up Keck spectroscopy confirms that the two optical nuclei share a common redshift and independently exhibit broad Balmer emission and high-ionization AGN emission lines. Unlike most known dual AGN, which are typically found in massive mergers, J162209.41+352107.5 is a compact low-mass system analogous to galaxies thought to dominate early phases of galaxy assembly. These findings demonstrate that efficient growth of multiple SMBHs can occur in such environments and establish Green Pea galaxies as nearby laboratories for investigating the interplay between galaxy interactions, star formation, and black-hole growth under conditions analogous to those prevalent in the young Universe.

While the growth of galaxies at high redshift is thought to be dominated by compact, intensely star-forming systems [e.g., 1], the corresponding growth of supermassive black holes (SMBHs) within such environments remains poorly constrained [e.g., 2]. Nearby analogs provide a unique laboratory for investigating how star formation and SMBH growth are coupled, enabling detailed multiwavelength studies that remain challenging for comparable systems at high redshift. Green Pea galaxies are among the best-studied examples of such systems. Originally identified in the Sloan Digital Sky Survey (SDSS) by their strong [O III] $\lambda 5007$ emission [3], they are compact ($r_{50,UV} \sim 0.3$ kpc), low-metallicity ($12 + \log(O/H) \sim 8.1$) systems with extreme ionization conditions ($O32 \sim 5$) and high specific star-formation rates ($sSFR \sim 10^{-8.3} \text{ yr}^{-1}$) [e.g., 4–8]. A subset host active galactic nuclei (AGN) [3, 9–12], demonstrating that rapid SMBH growth can occur even within compact galaxies undergoing intense star formation.

Dual AGN, in which two SMBHs accrete simultaneously within an interacting galaxy system, trace an important phase of galaxy evolution and SMBH growth [e.g., 13–15]. Despite extensive searches, confirmed dual AGN remain rare and are predominantly found in massive, gas-rich mergers at $z \lesssim 1$ [e.g., 15–18]. Although several Green Pea galaxies have been reported to exhibit double-peaked [O III] emission suggestive of dual AGN activity [10], such features can also arise from outflows or complex gas kinematics [e.g., 19–22]. To our knowledge, no confirmed dual AGN has previously been established in a compact, low-mass, metal-poor galaxy [e.g., 15].

Recent, *James Webb Space Telescope* (*JWST*) observations have further highlighted the importance of rapidly accreting SMBHs in compact galaxies, including the so-called “Little Red Dots” [e.g., 1, 23–25]. Together with nearby Green Pea AGN that exhibit spectroscopic and interstellar-medium properties similar to those inferred for compact galaxies in the early Universe [e.g., 11, 26, 27], these findings reinforce the view that Green Pea galaxies provide valuable local laboratories for investigating SMBH growth and its connection to star formation under conditions analogous to those prevalent during early galaxy assembly.

Among the Green Pea AGN population, SDSS J162209.41+352107.5 (hereafter J1622+3521) emerged as a promising candidate for follow-up observations owing to its irregular optical morphology and previous classification as a narrow-line Seyfert 1 galaxy [3]. Deep optical imaging reveals a morphology characteristic of an advanced merger, with two distinct nuclei embedded within diffuse stellar emission (Fig. 1). Faint asymmetric structures extend predominantly along the east–west direction, consistent with tidal debris produced by an ongoing interaction. The optical nuclei coincide with two spatially resolved hard X-ray sources detected by the *Chandra X-ray Observatory* (*Chandra*), indicating that both stellar components host actively accreting nuclei.

To determine whether the two nuclei are physically associated and to constrain their ionization properties, we obtained Keck/DEIMOS long-slit spectroscopy simultaneously covering both components. The resulting two-dimensional spectrum reveals two spatially separated emission-line systems associated with the optical nuclei (Fig. 2). The spectra confirm that the two components share a common redshift ($z = 0.267$) and are therefore physically associated. Both nuclei independently exhibit broad Balmer emission, high-ionization lines, and AGN-like emission-line ratios.

The combined X-ray and optical observations establish J1622+3521 as the first confirmed dual AGN hosted within a Green Pea system. *Chandra* spectroscopy reveals two luminous hard X-ray sources with intrinsic luminosities of $\log(L_{2-10\text{ keV}}/\text{erg s}^{-1}) \simeq 43.9$ and 43.6 for Source 1 and Source 2, respectively, consistent with actively accreting SMBHs. The Keck spectra independently show broad $\text{H}\alpha$ emission with FWHM ~ 1900 and $\sim 1700\text{ km s}^{-1}$, together with high-ionization emission lines including $\text{He II } \lambda 4686$, $[\text{Ne V}] \lambda\lambda 3346, 3426$, and $[\text{Fe VII}] \lambda 6087$, which are commonly associated with AGN activity. Narrow-line emission-line diagnostics place both nuclei firmly within the AGN region of the Baldwin–Phillips–Terlevich (BPT) diagram, a standard tool used to distinguish AGN photoionization from star formation. Virial estimates imply black-hole masses of $\log(M_{\text{BH}}/M_{\odot}) \simeq 7.3$ for both nuclei, while the inferred Eddington ratios of $\lambda_{\text{Edd}} \simeq 0.7$ and $\simeq 0.3$ indicate efficient ongoing SMBH growth. The projected separation of $\sim 8.4\text{ kpc}$ suggests that the system is being observed during a pre-coalescence phase in which both SMBHs remain simultaneously active.

Unlike the broader dual-AGN population, which is dominated by massive gas-rich mergers [e.g., 15, 18, 28–32], J1622+3521 resides in a compact Green Pea system while hosting a dual AGN. Its host-galaxy environment extends the known dual-AGN population into a regime of compact, intensely star-forming, low-metallicity galaxies that are not represented among previously confirmed dual-AGN hosts. Despite their comparatively modest stellar masses, both nuclei host luminous AGN accreting at substantial fractions of the Eddington limit, indicating efficient SMBH growth.

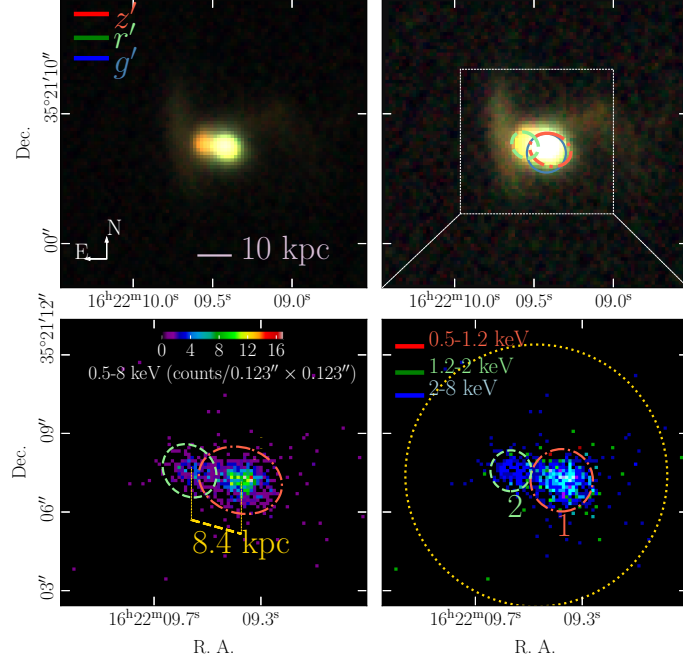


Fig. 1 Optical and X-ray views of J1622+3521. (*Upper left*) DECaLS optical composite image combining the z , r , and g bands mapped to RGB colors. The pink bar indicates a projected physical scale of 10 kpc. (*Upper right*) The same DECaLS image is shown with enhanced contrast to highlight faint filamentary structures and tidal features associated with the ongoing interaction. The colored ellipses mark the source-detection regions of the two X-ray sources identified in the *Chandra* image (lower left), while the blue square outlines the SDSS spectroscopic fiber. (*Lower left*) *Chandra* 0.5–8.0 keV image of the central region, showing two spatially resolved X-ray sources coincident with the optical nuclei. The color scale represents the total X-ray intensity. The yellow line marks the projected separation of 8.4 kpc between the X-ray source centroids. (*Lower right*) Three-color *Chandra* image with the soft (0.5–1.2 keV), medium (1.2–2.0 keV), and hard (2.0–8.0 keV) bands mapped to RGB colors. The red and green circles indicate the X-ray spectral extraction regions for Sources 1 and 2, respectively, while the yellow dashed circle marks the inner boundary of the background region.

J1622+3521 may represent a unique nearby analog of compact rapidly accreting AGN observed in the early Universe. Recent *JWST* observations have revealed large populations of compact galaxies hosting actively accreting SMBHs, including both classical AGN and the recently identified Little Red Dot [e.g., 24, 25] and Little Blue Dot populations [e.g., 33]. Recent studies further suggest that many compact high-redshift AGN are associated with close galaxy pairs or interactions, raising the possibility that merger-driven gas inflows play an important role in triggering rapid SMBH growth [34]. J1622+3521 provides direct evidence that interactions within compact star-forming galaxies can efficiently fuel the growth of multiple SMBHs. This supports the emerging picture that galaxy interactions may represent an important pathway for rapid black-hole growth across cosmic time and establishes Green Pea galaxies as nearby laboratories for investigating the connection between intense star

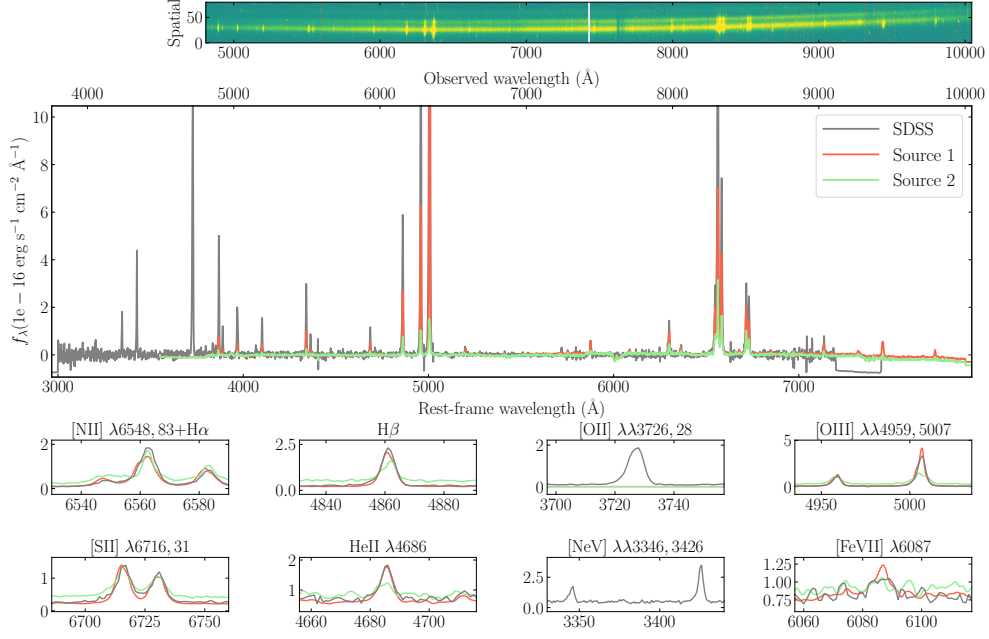


Fig. 2 Optical spectra of the X-ray-bright Source 1 (red) and Source 2 (green), obtained with Keck/DEIMOS, together with the SDSS fiber spectrum (gray). The upper panel shows the observed-frame two-dimensional spectrum, the middle panel the extracted rest-frame spectra, and the lower panels representative emission-line regions.

formation and SMBH growth under conditions analogous to those prevalent in the early Universe.

1 Methods

We perform an X-ray spectral and broadband analysis of J1622+3521 using 42.7 ks of newly obtained data from three *Chandra* observations (PI: K. Kouroumpatzakis; Observation IDs: 28142, 30637, and 30638). The X-ray analysis is complemented by optical long-slit spectroscopic observations acquired with Keck/DEIMOS. We also use archival DESI Legacy Imaging Survey [DeCaLS; 35] and SDSS data.

1.1 Optical Data

Follow-up optical spectroscopy was obtained with the DEIMOS spectrograph on the Keck II telescope on UT 2025 February 22. The observations were carried out in long-slit mode using the 600ZD grating and the GG400 order-blocking filter, providing a wavelength coverage of $\sim 4750\text{--}10050\text{ \AA}$ with a central wavelength of $\sim 7400\text{ \AA}$. The slit mask (“Long1.0B”) corresponds to a slit width of $1''$, yielding a spectral resolution of $R \sim 1370$ and a dispersion of $\sim 0.65\text{ \AA pix}^{-1}$. The observations were conducted at an airmass of ~ 1.2 under good conditions, with a guide-star FWHM of $\sim 0.88''$. The total integration time was 900 s, and the slit was oriented to simultaneously cover both optical counterparts associated with the X-ray emission.

The data were reduced using the `PyPeIt` pipeline [36], which performs bias subtraction, flat-fielding, wavelength calibration, sky subtraction, and optimal extraction of one-dimensional spectra. Flux calibration was performed using observations of the spectrophotometric standard star HZ44 obtained during the same night. The resulting two-dimensional spectrum (Figure 2, top panel) clearly shows two spatially separated emission components along the slit, corresponding to the two optical nuclei. Both components exhibit strong emission lines across the full spectral range. Although the data were rectified using the `PyPeIt` pipeline, small residual geometric distortions remain visible in the two-dimensional spectra, particularly toward the detector edges. Visual inspection confirms that the tracing algorithm successfully follows the continuum and emission-line structure across the full wavelength range for both components, and therefore these residual distortions do not affect the wavelength calibration or the extracted one-dimensional spectra used for the emission-line analysis.

Given the projected separation of only $\sim 1.9''$, some low-level spill-over between the extraction apertures is expected, particularly in the brightest emission lines. However, the two-dimensional spectrum clearly reveals distinct emission-line structures associated with each nucleus. In features such as [O III] $\lambda 5007$ and $H\alpha$, the spatial profiles become narrower between the two continuum traces and broaden again at the position of the second nucleus, demonstrating that the line emission is dominated by the respective sources rather than by cross-contamination. This behavior confirms that the measured velocity offset between the nuclei is intrinsic to the system and not an artifact of the extraction procedure.

The one-dimensional spectra of the two components are shown in Figure 2 (middle panel) and are consistent with those observed in the SDSS fiber spectrum. Both spectra exhibit strong emission lines, including the Balmer series ($H\alpha$, $H\beta$), prominent [O III] $\lambda\lambda 4959, 5007$, [N II] $\lambda\lambda 6548, 6583$, and [S II] $\lambda\lambda 6716, 6731$ transitions. Zoomed-in views of key diagnostic regions (Figure 2, lower panels) show that the emission-line

profiles are well resolved. In addition, high-ionization coronal lines such as [Ne V] $\lambda\lambda 3346, 3426$ and [Fe VII] $\lambda 6087$ are detected, supporting the presence of an active nucleus. Overall, the spectroscopic data confirm that both optical components are at consistent redshift and exhibit AGN-like emission-line properties, supporting the interpretation of a dual AGN system embedded in a merging host galaxy.

1.2 Optical Spectral Analysis

To further constrain the properties of the sources and their broad-line regions, we analyzed the continuum-subtracted optical spectra of J1622+3521 using Keck/DEIMOS spectra of Source 1 and Source 2, which have higher resolution than the SDSS spectrum. The underlying continuum was first modeled and removed using **FADO** [37], which self-consistently accounts for both stellar and nebular continuum emission. The resulting residual spectra were subsequently used for the emission-line analysis.

The DEIMOS spectra were transformed to an initial rest frame using the SDSS redshift of $z = 0.2665$ from the MPA-JHU catalog [38–40]. The systemic velocities of the individual nuclei were then obtained from the **FADO** modeling. At this redshift, the corresponding luminosity and angular diameter distances are 1399 and 872 Mpc, respectively. The best-fit **FADO** models yield redshifts of $z_{S1} = 0.2667 \pm 0.0001$ and $z_{S2} = 0.2667 \pm 0.0002$ for Source 1 and Source 2, respectively. These values correspond to velocity offsets of $\sim 61 \pm 42 \text{ km s}^{-1}$ and $\sim 68 \pm 61 \text{ km s}^{-1}$ relative to the systemic SDSS redshift. The implied velocity difference between the two nuclei is only $\sim 7 \text{ km s}^{-1}$ and is not significant given the uncertainties. Within the uncertainties, the two nuclei are therefore consistent with sharing a common systemic velocity, although modest internal kinematic differences associated with the ongoing interaction may still be present.

The astrometric and kinematic properties of the two nuclei are summarized in Table 1. The relative velocity difference between the two nuclei is small ($\Delta v \sim 7 \pm 74 \text{ km s}^{-1}$), consistent with an interacting pre-coalescence system observed close to the plane of the sky.

Table 1 Astrometric and kinematic properties of the two nuclei in Green Pea galaxy J1622+3521. Coordinates correspond to the centroids of the *Chandra* X-ray detections obtained with **wavdetect** (Section 1.3), while redshifts are derived from the **FADO** spectral modeling of the DEIMOS spectra.

Source	R.A.	Decl.	Redshift	Ang. sep.	Proj. sep.
Source 1	16:22:09.40	+35:21:07.2	0.2667 ± 0.0001	1.9''	8.4 kpc
Source 2	16:22:09.56	+35:21:07.6	0.2667 ± 0.0002		

We modeled the continuum-subtracted spectra using the **Sherpa** fitting package within CIAO [41, 42]. To account for additional uncertainties associated with the stellar-continuum subtraction and correlated noise introduced during the spectral processing, we adopted a total uncertainty per spectral pixel of $\sigma_{\text{tot}} = \sqrt{\sigma_{\text{stat}}^2 + (0.05|F|)^2}$, where σ_{stat} is the propagated statistical uncertainty and F is the observed flux density. The

resulting uncertainty spectrum was used for the emission-line fitting. Tests adopting different fractional uncertainties yielded consistent emission-line fluxes and widths, indicating that the inferred physical parameters are insensitive to the precise error normalization.

The $H\alpha$ region (6480–6660 Å) was fitted using a local constant continuum and four Gaussian components corresponding to narrow [N II] $\lambda 6548$, narrow [N II] $\lambda 6583$, narrow $H\alpha$, and a broad $H\alpha$ component. The [N II] doublet amplitudes were fixed to their theoretical ratio ($F_{6583}/F_{6548} = 2.96$), while the narrow components were initially constrained to share a common width. The $H\beta$ region (4830–4890 Å) was modeled independently using a local continuum together with narrow and broad Gaussian components (Figure 3). The line centroids were initialized at their laboratory wavelengths and subsequently allowed to vary within physically motivated ranges. The broad Balmer components were initialized with substantially larger FWHM values to account for potential broad-line region emission. The fitting was performed iteratively, first using narrow-only models and subsequently including broad components to evaluate whether the addition of a broad-line component significantly improves the fit. In addition, we modeled the He II $\lambda 4686$ and [O III] $\lambda\lambda 4959, 5007$ emission lines to further probe the ionized-gas properties and AGN excitation conditions. The He II line was fitted with a single Gaussian component, whereas the [O III] doublet was modeled using three Gaussian components per transition to reproduce the observed asymmetric line profiles.

For the $H\alpha$ complex, the inclusion of a broad component significantly improves the fits for both nuclei. For Source 1, the fit statistic decreases from $\chi^2 = 2187.8$ (712 degrees of freedom) for the narrow-only model to $\chi^2 = 741.9$ (707 degrees of freedom) after including the broad $H\alpha$ component, corresponding to $\Delta\chi^2 = 1445.9$ for five additional free parameters. Similarly, Source 2 improves from $\chi^2 = 2741.5$ (712 degrees of freedom) to $\chi^2 = 1270.8$ (707 degrees of freedom), corresponding to $\Delta\chi^2 = 1470.7$. In both cases, the narrow-only models leave clear systematic residuals in the Balmer wings, whereas the addition of a broad component successfully reproduces the extended line profiles. The results of the fitting process are summarized in Table 2. The broad $H\alpha$ FWHM values of $\sim 1900 \text{ km s}^{-1}$ for Source 1 and $\sim 1700 \text{ km s}^{-1}$ for Source 2 are consistent with emission originating from a broad-line region associated with narrow-line Seyfert 1 AGN activity.

The inclusion of a broad $H\beta$ component also significantly improves the fits for both nuclei. For Source 1, the fit statistic decreases from $\chi^2 = 230.3$ (235 degrees of freedom) to $\chi^2 = 98.5$ (233 degrees of freedom), corresponding to $\Delta\chi^2 = 131.8$ for two additional free parameters. For Source 2, the fit improves from $\chi^2 = 405.4$ (235 degrees of freedom) to $\chi^2 = 243.9$ (233 degrees of freedom), corresponding to $\Delta\chi^2 = 161.5$. These improvements independently support the presence of broad $H\beta$ emission in both nuclei. However, because broad $H\beta$ is intrinsically fainter than broad $H\alpha$, its measured properties are expected to be more sensitive to uncertainties in the continuum subtraction and spectral decomposition. We therefore regard the broad $H\beta$ parameters as less well constrained than those derived from broad $H\alpha$. The residuals shown in Figure 3 exhibit no strong systematic structures after the inclusion of the

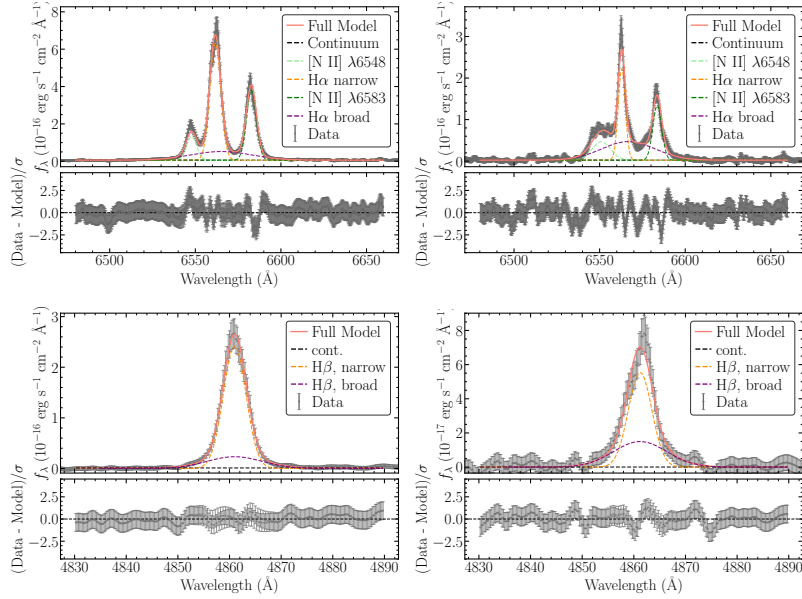


Fig. 3 Multi-component Gaussian fits to the $H\alpha$ and $H\beta$ emission-line regions in the continuum-subtracted spectra of J1622+3521. The top panels show the $H\alpha$ region and the bottom panels the $H\beta$ region for the Keck/DEIMOS spectra of Source 1 (left) and Source 2 (right). The salmon-colored curve represents the total best-fit model, while the dashed black line marks the local continuum level. In the $H\alpha$ region, the fits include narrow $[N II] \lambda\lambda 6548, 6583$, a narrow $H\alpha$ component, and a broad $H\alpha$ component. The $H\beta$ region is modeled using narrow and broad $H\beta$ Gaussian components. Residuals are shown in the lower panels in units of the statistical uncertainty, σ .

broad Balmer components, indicating that the adopted Gaussian parameterization adequately describes the observed emission-line profiles.

1.3 X-ray data & source detection

The individual *Chandra* observations were first reprocessed using the `chandra_repro` task to ensure the application of the latest calibration files and screening criteria. Before combining the datasets, the absolute astrometric alignment of each reprocessed event file was refined using the CIAO tools `wcs_match` and `wcs_update`, which register all observations to a common celestial reference frame. Subsequently, each observation was reprojected to the tangent point of the first observation using the `reproject_obs` task, ensuring a consistent world-coordinate system (WCS) across all files. The reprojected event files were then merged into a single dataset by combining their photon lists with consistent WCS parameters.

The resulting merged event file was used to generate energy-filtered images in the soft (0.5–1.2 keV), medium (1.2–2 keV), hard (2–8 keV), and full (0.5–8 keV) bands using the `dmcopy` tool. Exposure maps corresponding to each observation were also created and combined to account for variations in exposure time and instrumental response across the field. An exposure-corrected flux image was then produced with

the `fluximage` task, enabling the construction of images with uniform photometric scaling. For visualization purposes, the merged event file was binned to a pixel scale of $0.123''$, corresponding to one-quarter of the native ACIS pixel size. The resulting images are presented in Figure 1.

Source detection was performed using CIAO’s `wavdetect` algorithm [43], which identifies statistically significant structures by correlating the X-ray image with a series of *Mexican-hat* wavelets of increasing scale. We applied `wavdetect` to the native-resolution ($0.492''/\text{pixel}$) image using standard wavelet scales. The identified sources are shown in the bottom left panel of Figure 1. Their centroids are at 16:22:09.40, 35:21:07.2 (Source 1, west), and 16:22:09.56, 35:21:07.6 (Source 2, east). The angular distance between the two detected X-ray centroids is $1.9''$, corresponding to a projected physical distance $d \simeq 8.4$ kpc. The positions of the two optical centroids are spatially coincident with the two X-ray point sources identified in the *Chandra* observations. However, for the spectral analysis, and to avoid overlap and cross-contamination from the *Chandra* point-spread function (PSF), we adopt more compact circular apertures centered on the `wavdetect` positions with a radius of $1.19''$, and $0.78''$ for Sources 1 and 2, respectively (Figure 1, bottom right).

1.4 X-ray spectral analysis

We extracted spectra for both targets separately from each of the three *Chandra* observations using the CIAO `specextract` task. A single annular background region was constructed and used for both targets within all observations, centered at their mid-point with inner and outer radii of 7 arcsec and 20 arcsec, respectively. For each of the six corresponding spectra extracted, we used source + background circular regions for the West and East sources, respectively. We then used `specextract` to produce the on and off spectra with their corresponding response files after applying the appropriate exposure weighting and PSF corrections.

For both targets, we then separately combined their three epoch spectra after manually confirming that no significant intra-epoch variability had occurred. The CIAO `combine_spectra` command was used to merge the spectra and generate the corresponding exposure- and response-weighted ARFs and RMFs. The corresponding individual spectra generated for both targets were used for all subsequent analyses. Our primary aim from the X-ray spectral analysis was to derive robust intrinsic X-ray luminosities and line-of-sight column densities for both targets. A number of crucial considerations were required: (i) *Blending*: the proximity of either target to one another meant that our fitting methodology needed to account for some level of blending, such that the X-ray spectra of both targets needed to be fit simultaneously to one another. (ii) *Background*: the signal-to-noise ratio of either source was not equal, with the East source being sub-dominant to the background at soft X-ray energies. Thus proper consideration of the background was essential to account for its effects on the resulting parameter posteriors. (iii) *Self-consistent X-ray spectral modelling*: the nature of the obscuration had to be considered with some levels of physical realism.

The study of quasar and Seyfert AGN X-ray obscuration has been refined over decades of development (see e.g. [44] for a recent review). However, the study of AGN obscuration within compact low-metallicity galaxies is considerably more novel

and unexplored. Whilst low metallicity is known to have a significant impact on photoelectric absorption [45], there is currently very little understanding as to the connection between host galaxy metallicity and that of the circum-nuclear obscurer. Thus, our spectral fitting methodology needed to be sophisticated enough to consider low obscurer metallicity as a nuisance parameter such that our line-of-sight column densities and obscuration-corrected luminosities were as accurate as possible. For this purpose, we relied on the physically self-consistent spherical obscuration model of [46], which we refer to as **BNsphere**. With additional variable iron as well as other metal abundances as two separate parameters, **BNsphere** correctly accounts for Compton scattering, fluorescence, and photoelectric absorption occurring from a fully-covering sphere of obscuring gas to provide an estimated line-of-sight column density. We note that whilst a completely spherical obscurer is a difficult geometry to sustain in nature, it is the simplest possible geometry to assume in a physically self-consistent manner. Furthermore, the instigation of AGN obscuration during mergers is predicted to maximise the covering factor of the obscurer (e.g. [47–49]), and we note that such high covering factor obscurers are commonly invoked for Little Red Dots, such as quasi-star models in which rapidly accreting black holes are embedded within dense, optically thick gaseous envelopes [50].

Our X-ray spectral fits were performed within **PYXSPEC** – the Python wrapper of **XSPEC** v12.12.1 [51, 52] with the Poisson likelihood described by the C-statistic [53] and the Bayesian X-ray Analysis package (**BXA**; [54, 55]) using the Python wrapper of the nested sampling package **MULTINEST** [54, 56, 57]. We use a sampling efficiency of 10^{-3} with 10^4 live points within **MULTINEST** as a means to optimise the robustness of the reconstructed parameter posteriors [58]. The spectral fit included fixed Galactic absorption along the line-of-sight to both sources with $N_{\text{H, Gal}} = 1.03 \times 10^{20} \text{ cm}^{-2}$ [59] using the **TBabs** model and abundances from [60]. All spectral fitting parameter estimates are listed as the mode of their respective posterior distributions with uncertainties quoted as the 90% Highest Density Interval.

1.4.1 Free Parameters

To incorporate as much information as possible from the observed data in our fits, we include no binning and instead rely on a background model to avoid systematic fitting biases (see e.g. [61]). For convenience, we choose to use the automated background models that are publicly accessible through **BXA**. Background model templates were generated by fitting large samples of background observations for a variety of instruments using Principle Component Analysis (PCA) by [62]. The automated background fitter within **BXA** then takes the PCA models of [62] and performs a bespoke fit for each of the three X-ray background spectra we analyse in this work, making sure to include additional Gaussian emission lines if statistically required. We visually verify for each spectrum that the background model provides an acceptable fit to the observed background spectra before incorporating the model into our X-ray spectral fits. Since the PCA components that make up each background model do not necessarily represent physical components, it would not make physical sense to let those components all vary freely during the fit. However, to include some level of realistic noise arising from the imperfect knowledge of the background we do allow the overall

normalisation of each full background model to vary as a free parameter along with the spectral parameters of each fit. The background scaling normalisation is allowed to vary with a log-uniform prior over two orders of magnitude centered at the expected value.

We assume the same X-ray spectral model for both sources, with two additional pre-multiplying ‘mixing’ constants to account for the contaminating flux from Source 1 in the Source 2 spectrum and vice-versa. Each source spectrum comprises the AGN emission represented with the **BNsphere** model and a soft X-ray powerlaw designed to reproduce any residual flux that arises from unresolved X-ray binaries in either host galaxy and/or AGN primary emission leaking through small gaps in the primary obscurer. Per source, the **BNsphere** model has variable photon index and normalisation of the primary coronal continuum, which we assign a Gaussian prior of 1.80 ± 0.15 (a conservative assumption consistent with previous AGN studies, e.g. [63], designed to avoid artificially hard spectral shapes; c.f. [64]) and a log-uniform prior between $10^{-10} - 1$, respectively. The line-of-sight column density of the obscurer was assigned a log-uniform prior between $10^{20} - 10^{26} \text{ cm}^{-2}$, and its elemental composition was assigned log-uniform priors between 0.1–1 Solar metallicity for the iron abundance and joint abundance of all other metals. The contaminating soft X-ray component was allowed to vary in normalisation with a log-uniform prior, but was forced to never exceed 10% of the primary AGN continuum. Its photon index was also allowed to vary with a uniform prior between 1–10. Considering each source had a total of nine free parameters, including contamination mixing and background normalisation, our full model was described by 18 total free parameters.

1.5 X-ray Spectral Fitting Results

The joint fit to the *Chandra* spectra of Source 1 and 2 is shown in Figure 4, in which the model is able to simultaneously explain the observed source + background and background spectra well. We find a logarithmic line-of-sight column density for Source 1 and 2 of $\log(N_{\text{H}} / \text{cm}^{-2}) = 22.8^{+0.5}_{-0.2}$ and $23.6^{+0.4}_{-0.5}$, respectively. The corresponding logarithmic intrinsic 2–10 keV luminosities for Source 1 and 2 are $\log(L_{2-10 \text{ keV}} / \text{erg s}^{-1}) = 43.93^{+0.04}_{-0.05}$ and 43.55 ± 0.11 , respectively. We note that the general effect of including variable metallicities for either source as nuisance parameters has increased the level of uncertainty for column density that is self-consistently included in the ultimate estimate of intrinsic luminosity, as required. Lastly, we find intrinsic coronal photon index estimates of $1.76^{+0.20}_{-0.21}$ and $1.79^{+0.25}_{-0.23}$ for Source 1 and 2, respectively. The broad consistency with the input prior of 1.80 ± 0.15 is clear, suggesting that the measured spectra are insensitive to the parameter under the adopted model. A plausible reason is the result of competing parameters describing the overall spectral shape of either source (e.g., metallicity, line-of-sight column density, contamination mixing fractions). Given the substantial luminosity of both sources above 2 keV and their overall spectral shapes, our X-ray spectral fitting unambiguously confirms their AGN nature.

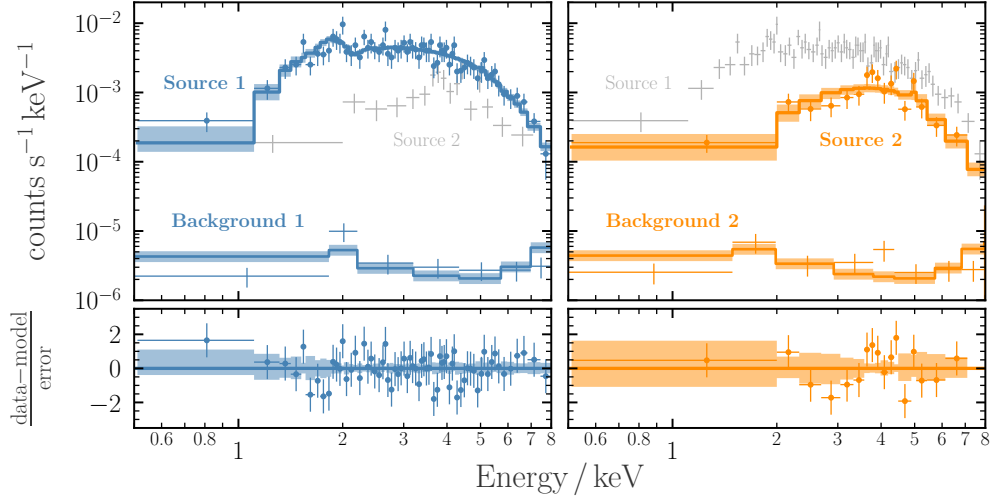


Fig. 4 Left and right panels present the X-ray spectral posterior constraints for Source 1 and 2 in blue and orange, respectively. In both panels, the corresponding background spectrum and fit relevant to the source considered is shown in the bottom portion of the spectral panels. The lower portion of the left and right panels presents the residuals of the source + background data with error bars, as well as the posterior range around the median with shaded regions.

1.6 IR photometry

Additionally, we examine the infrared properties of J1622+3521 as observed with the Wide-field Infrared Survey Explorer (*WISE*; [65]). J1622+3521 appears unresolved due to the relatively large point spread function of the *WISE* bands, which is $\geq 5.6''$ in W1 and increases to $\sim 12''$ in W4. We adopt the photometry reported in the AllWISE Source Catalog¹. J1622+3521 is red in the near- and mid-IR bands covered by *WISE* (Figure 1), with $W1 - W2 = 1.38 \pm 0.03$ mag and $W2 - W3 = 3.05 \pm 0.03$ mag. These colors place the source well within the AGN selection wedges defined by [66–69]. Moreover, the *WISE* colors of J1622+3521 are consistent with those of the majority of IR-detected Green Pea galaxies, which, however, were not classified as AGN based on their optical spectra [e.g., 8, 70].

1.7 Optical emission-line diagnostics

To further investigate the dominant ionization mechanism in the two nuclei, we constructed a Baldwin–Phillips–Terlevich (BPT) diagnostic diagram [71] using the narrow emission-line ratios derived from the spectral decomposition (Table 2). Figure 5 shows the locations of Source 1 and Source 2 in the $\log(f_{[\text{OIII}]\lambda 5007}/f_{\text{H}\beta})$ versus $\log(f_{[\text{NII}]\lambda 6583}/f_{\text{H}\alpha})$ plane. All three measurements lie securely within the AGN region of the diagram [72–74], confirming that the optical line emission is dominated by photoionization from accreting supermassive black holes rather than by star formation

¹<https://irsa.ipac.caltech.edu/data/WISE/docs/release/AllWISE/>

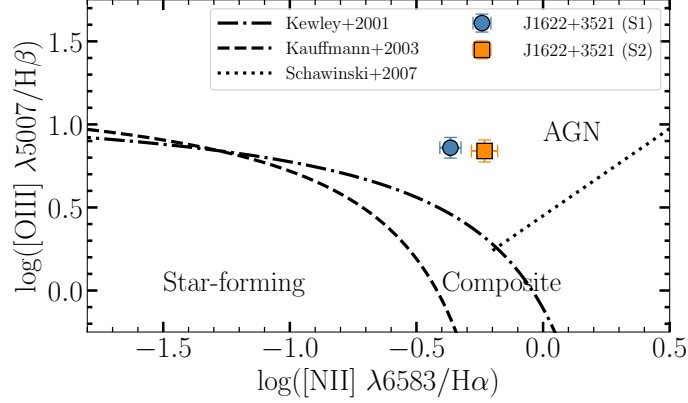


Fig. 5 BPT diagnostic diagram for J1622+3521 based on the narrow emission-line ratios derived from the spectral decomposition. The blue circle and orange square correspond to the DEIMOS measurements of Source 1 and Source 2, respectively. The dashed, dash-dotted, and dotted curves show the classification boundaries from [73], [72], and [74], respectively.

alone. The two DEIMOS nuclei occupy very similar positions, with high excitation ratios of $\log([\text{O III}]/\text{H}\beta) \sim 0.9$.

Therefore, the BPT classification independently supports the dual-AGN interpretation inferred from the X-ray luminosities and broad Balmer emission. Combined with the luminous hard X-ray emission and signatures from a broad-line region, the optical narrow-line ratios establish J1622+3521 as a bona fide dual AGN system hosted within a compact Green Pea galaxy. This interpretation is further reinforced by the detection of high-ionization (coronal) emission lines such as $[\text{Ne V}] \lambda\lambda 3346, 3426$ and $[\text{Fe VII}] \lambda 6087$ in the DEIMOS and SDSS spectra (Figure 2). The production of these ions requires photons with energies of ~ 97 and ~ 99 eV, respectively, well above those typically produced by stellar populations, and therefore, they are widely regarded as robust signatures of AGN photoionization and actively accreting supermassive black holes [e.g., 75–77].

1.8 Broad-line emission and black hole mass estimates

We estimate supermassive black hole masses using single-epoch virial scaling relations based on the broad $\text{H}\alpha$ emission [e.g., 78–80]. Throughout this work, we adopt the calibration of [80], which is optimized for low-mass broad-line AGN systems similar to J1622+3521. To estimate the extinction toward the broad-line region (BLR), we used the broad $\text{H}\alpha/\text{H}\beta$ Balmer decrements, assuming an intrinsic ratio of 3.1 commonly adopted for broad-line AGN [e.g. 78, 81, 82] and adopting the attenuation law of [83]. This yields $E(B - V)_{\text{BLR}} = 0.65 \pm 0.26$ for Source 1 and 0.92 ± 0.32 for Source 2. The intrinsic BLR Balmer decrement remains somewhat uncertain, with values of ~ 2.7 also reported in the literature [e.g., 84]. Using such values would lead to modestly larger extinction corrections but would not alter the main conclusions of this work. For comparison, the narrow-line Balmer decrements imply $E(B - V)_{\text{NLR}} \simeq 0.19$ and $\simeq 1.01$, respectively. The substantially larger BLR reddening in Source 1 suggests

additional obscuration toward the nuclear region, whereas the broad- and narrow-line extinctions are broadly consistent in Source 2. Such differences between BLR and NLR reddening are commonly observed in AGN and indicate that the two emitting regions need not experience the same line-of-sight extinction [e.g., 82].

Using the extinction-corrected broad $H\alpha$ luminosities and broad-line FWHM measurements, we derive:

- Source 1: $\log(M_{\text{BH}}/M_{\odot}) = 7.31 \pm 0.13$,
- Source 2: $\log(M_{\text{BH}}/M_{\odot}) = 7.29 \pm 0.16$,

The quoted uncertainties reflect the propagated statistical uncertainties from the luminosity and FWHM measurements only and do not include the intrinsic systematic scatter of ~ 0.4 – 0.5 dex associated with single-epoch virial supermassive black hole mass estimators. For comparison, the [79] calibration yields masses that differ by only a few tenths of a dex and does not alter the main conclusions of this work.

We also measured stellar velocity dispersions from the optical spectra fits with FADO. However, we do not adopt black hole masses derived from the local $M_{\text{BH}}-\sigma_*$ relation. In compact interacting systems such as J1622+3521, the observed stellar kinematics may be influenced by rotation, tidal motions, and non-equilibrium dynamical effects associated with the merger, such that the measured velocity dispersions may not represent the relaxed bulge kinematics assumed by local $M_{\text{BH}}-\sigma_*$ calibrations [e.g., 85, 86]. We therefore adopt the broad $H\alpha$ -based virial black hole masses throughout this work.

1.9 Accretion properties and Eddington ratios

Using the intrinsic X-ray luminosities derived from the BXA spectral modeling together with the virial supermassive black hole masses inferred from the broad $H\alpha$ emission, we estimate the accretion properties of both nuclei. The absorption-corrected 2–10 keV luminosities are $\log(L_{2-10\text{ keV},1}/\text{erg s}^{-1}) = 43.93 \pm 0.02$ and $\log(L_{2-10\text{ keV},2}/\text{erg s}^{-1}) = 43.55 \pm 0.06$ for Source 1 and Source 2, respectively.

Adopting a bolometric correction of $k_{\text{bol}} = 20$, appropriate for rapidly accreting NLS1-like systems [e.g., 87–89], we derive:

$$\log(L_{\text{bol},1}/\text{erg s}^{-1}) = 45.23 \pm 0.02, \quad (1)$$

$$\log(L_{\text{bol},2}/\text{erg s}^{-1}) = 44.85 \pm 0.06. \quad (2)$$

Combining these values with the virial supermassive black hole masses yields Eddington ratios of:

$$\log(\lambda_{\text{Edd},1}) = -0.18 \pm 0.13, \quad (3)$$

$$\log(\lambda_{\text{Edd},2}) = -0.54 \pm 0.17, \quad (4)$$

corresponding to $\lambda_{\text{Edd}} = 0.66$ and 0.29 for Source 1 and Source 2, respectively. The quoted uncertainties reflect the propagated statistical uncertainties from the virial mass estimates and X-ray luminosities, while the true systematic uncertainties are likely larger owing to the intrinsic scatter associated with single-epoch virial

supermassive black hole mass estimators and bolometric corrections. Both nuclei are therefore accreting efficiently, with Source 1 exhibiting a particularly high accretion rate characteristic of rapidly growing Seyfert 1 and NLS1-like systems.

The adopted bolometric correction is broadly consistent with values inferred for local Seyfert 1 and NLS1-like AGN. Reasonable variations in k_{bol} within the range commonly reported for such systems ($k_{\text{bol}} \sim 10\text{--}30$) would shift the inferred Eddington ratios by only ~ 0.2 dex and would not affect the main conclusions.

As an independent check on the bolometric luminosities, we estimated L_{bol} from the extinction-corrected broad $\text{H}\alpha$ luminosities using the empirical relation of [90]. This yields $\log(L_{\text{bol}}/\text{erg s}^{-1}) \simeq 44.89$ for Source 1 and $\simeq 45.09$ for Source 2. The broad-line and X-ray-based bolometric luminosities differ by only $\sim 0.2\text{--}0.4$ dex. Given the substantial uncertainties associated with the extinction corrections, broad-line luminosities, and bolometric conversions, the two estimates are broadly consistent within the expected systematic scatter.

1.10 Comparison between He II and X-ray emission

To further investigate the connection between the ionizing radiation field and the accretion properties of the two nuclei, we compare the observed He II $\lambda 4686$ luminosities with the observed soft X-ray luminosities in the 0.5–2 keV band. The He II emission line traces photons with ionization energies above 54.4 eV and is therefore sensitive to the presence of hard ionizing radiation. Although nebular He II emission can arise from several mechanisms, including AGN activity, shocks, X-ray binaries, and very young stellar populations (e.g., Wolf-Rayet stars), the observed narrow He II/ $\text{H}\beta$ ratios of ~ 0.19 and ~ 0.25 for Source 1 and Source 2 place both nuclei firmly within the AGN-dominated regime of the diagnostic diagrams presented by [91]. Together with the detection of the high-ionization lines [Ne V] and [Fe VII], this suggests that stellar photoionization alone is unlikely to generate the hard ionizing continuum required to produce the observed He II emission.

The measurements for Source 1 and Source 2 are compared with the empirical AGN relation derived by [92] in Figure 6. Both nuclei lie very close to the empirical He II–soft X-ray relation and remain fully consistent with its intrinsic scatter. We additionally compare the system with the recently discovered X-ray-detected Red Dot (XRD) presented by [93]. The X-ray Dot occupies the high-luminosity extension of the same relation and lies broadly consistent with the AGN sequence traced by J1622+3521. The agreement between the X-ray Dot and J1622+3521 suggests that compact, rapidly accreting supermassive black holes may follow a common ionizing-continuum scaling relation across several orders of magnitude in luminosity and a wide range of cosmic epochs.

The consistency between the soft X-ray and He II luminosities provides independent evidence that J1622+3521 hosts two actively accreting supermassive black holes embedded within compact, highly ionized environments. More generally, this comparison provides additional support for using narrow He II emission as a proxy for intrinsic AGN power in compact and partially obscured systems where direct X-ray measurements or broad-line diagnostics may be difficult to obtain.

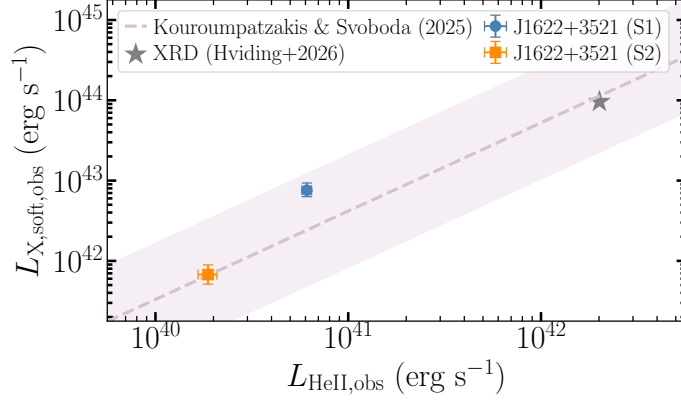


Fig. 6 Comparison between the observed narrow He II $\lambda 4686$ luminosity and the observed soft X-ray luminosity (0.5–2 keV) for the two nuclei of J1622+3521. The dashed line and shaded region show the empirical AGN relation and intrinsic scatter derived by [92]. Blue and orange symbols correspond to Source 1 and Source 2, respectively. The gray star symbol marks the “X-ray Dot” from [93].

1.11 Comparison with local AGN and dual-AGN populations

The intrinsic broad $H\alpha$ and 2–10 keV X-ray luminosities of the two nuclei are compared with the empirical AGN relation of Shimizu et al. [94] in Figure 7. The relation of [94] was originally calibrated using the absorption-corrected 14–150 keV luminosities of *Swift*/BAT-selected AGN. To facilitate comparison with our measurements, we converted the relation to the 2–10 keV band assuming a power-law X-ray spectrum with photon index $\Gamma = 1.8$, yielding a constant luminosity scaling between the two bands. The broad $H\alpha$ luminosities have been corrected for BLR extinction using the broad-line Balmer decrements (Section 1.8). The corresponding observed luminosities are lower by approximately 0.7–0.9 dex.

Source 2 lies fully consistent with the local AGN relation within the intrinsic scatter, while Source 1 remains marginally offset toward higher X-ray luminosities at fixed broad $H\alpha$ luminosity. Nevertheless, both nuclei occupy the locus expected for local broad-line AGN, indicating broad agreement between their extinction-corrected broad-line and intrinsic X-ray luminosities. The modest offset of Source 1 is comparable to the intrinsic scatter of the [94] relation and may reflect a combination of variability between the optical and X-ray observations, uncertainties in the extinction correction, or uncertainties in the intrinsic X-ray luminosity associated with the absorber geometry, column density, and assumed spectral model.

The weaker broad $H\beta$ emission relative to broad $H\alpha$ may indicate partial obscuration of the broad-line region, commonly observed in partially obscured Seyfert galaxies and intermediate-type AGN [e.g., 81, 95]. The broad-line Balmer decrements imply $E(B-V)_{\text{BLR}} = 0.65 \pm 0.26$ and 0.92 ± 0.32 for Sources 1 and 2, respectively, confirming the presence of significant nuclear reddening. Consistent with the broad-line reddening measurements, the X-ray spectral properties also indicate significant nuclear obscuration in both nuclei, with $\log(N_{\text{H}}/\text{cm}^{-2}) \simeq 22.9$ and $\simeq 23.6$ for Source 1 and Source 2, respectively. Such column densities are consistent with the substantial obscuration

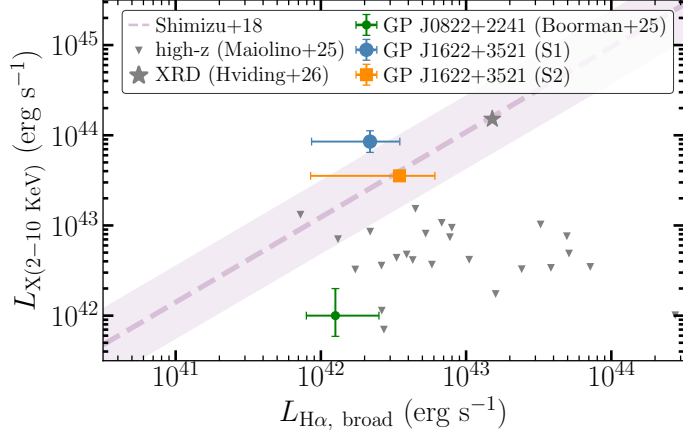


Fig. 7 Comparison between the extinction-corrected broad $H\alpha$ luminosity and the intrinsic 2–10 keV X-ray luminosity for J1622+3521. Blue and orange points correspond to Source 1 and Source 2, respectively. The dashed line and shaded region show the empirical AGN relation of [94] and its intrinsic scatter. The green point marks the Green Pea galaxy J0822+2241 from [12], while gray triangles indicate upper limits from compact high-redshift AGN [93].

frequently observed in merger-driven AGN, although they remain below the Compton-thick columns measured in some nearby dual-AGN systems [e.g., 30, 32]. Comparing the X-ray column densities with the reddening inferred from the broad-line Balmer decrements yields $N_H/E(B - V)$ ratios approximately 17 and 75 times larger than the canonical Galactic value [96, 97]. Such elevated gas-to-dust ratios are commonly observed in Seyfert galaxies and other AGN [98, 99], and are generally interpreted as evidence that a significant fraction of the absorbing gas resides in the circumnuclear AGN environment, potentially within or near the dust sublimation radius, rather than in the host-galaxy interstellar medium.

While recent studies suggest that Green Pea galaxies reside in low-density large-scale environments [100], morphological studies increasingly support a connection between mergers and AGN triggering in compact star-forming galaxies. For example, [101] found that a substantial fraction of Green Pea candidates exhibit disturbed morphologies or merger signatures [see also 102]. J1622+3521, therefore, provides direct observational evidence that merger-driven SMBH growth can occur within the Green Pea population.

Recent studies have identified only a small number of candidate dual AGN systems in dwarf and low-mass galaxy mergers [e.g., 103, 104]. Compared with the broader dual-AGN population [e.g., 15, 18, 28–32], J1622+3521 is unusual not because it exhibits signatures of an ongoing interaction, but because of the nature of its host galaxy. Like many confirmed dual AGN, the system shows dual nuclei and morphological signatures of an ongoing merger. Its distinguishing feature is that both actively accreting SMBHs reside within a compact Green Pea galaxy characterized by intense star formation, extreme ionization conditions, and a relatively low stellar mass. The detection of two actively accreting AGN in such an environment extends the known dual-AGN population into a host-galaxy regime that remains poorly represented in

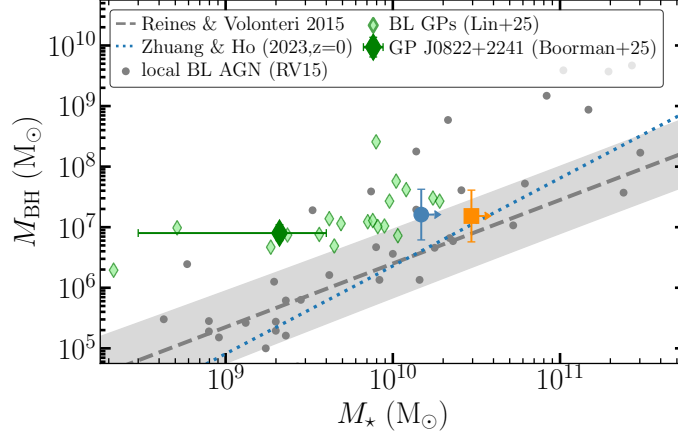


Fig. 8 Black hole mass versus stellar mass for J1622+3521 compared with local supermassive black hole–host galaxy scaling relations. The dashed gray line and shaded region indicate the best-fit relation and intrinsic scatter from [105], while the dotted blue line shows the AGN relation of [106] evolved to $z = 0$. Gray circles represent the local broad-line AGN sample compiled by [105]. Light green diamonds show the broad-line Green Pea (BLGP) galaxies identified by [11]. The blue and orange symbols correspond to Source 1 and Source 2 of J1622+3521, using virial supermassive black hole masses derived from the broad $H\alpha$ emission and stellar masses obtained from the FADO spectral decomposition. The green point marks the comparison AGN Green Pea J0822+2241 from [12].

current samples. Despite its comparatively modest stellar mass, both nuclei exhibit Seyfert-like X-ray luminosities and relatively high Eddington ratios, indicating efficient SMBH growth within a compact Green Pea environment.

1.12 Black hole and host-galaxy properties

The inferred supermassive black hole and stellar masses are shown in Figure 8, where we compare J1622+3521 with the local supermassive black hole–stellar mass relations of [105] and [106]. The stellar masses were obtained from the FADO spectral decomposition of the DEIMOS spectra and therefore correspond to the stellar populations sampled by the spectroscopic extraction apertures associated with each nucleus. Because the masses are derived from aperture spectra rather than integrated imaging, they may underestimate the total stellar masses associated with the interacting galaxies. However, the compact morphology of the system suggests that this effect is unlikely to exceed the level of a few tenths of a dex. The inferred black hole masses are less sensitive to aperture effects, as they are derived from the nuclear broad-line emission. Consequently, the true locations of the two nuclei in the $M_{\text{BH}}-M_{\star}$ plane could shift modestly toward higher stellar masses, moving them slightly to the right in Figure 8.

Within the uncertainties, both nuclei lie broadly consistent with the loci defined by nearby AGN and galaxies despite the compact, intensely star-forming, and interacting nature of the Green Pea system. The inferred black hole masses place both sources close to the local scaling relations of [105] and [106]. Although many of the broad-line Green Pea galaxies identified by [11] appear offset toward higher black hole masses at fixed

stellar mass, the two nuclei of J1622+3521 remain consistent with the overall scatter of the broad-line Green Pea population while residing closer to the local scaling relations. The comparison AGN Green Pea J0822+2241 [12] lies within the scatter of the broad-line Green Pea population and is similarly offset above the local scaling relations. Taken together, these comparisons suggest that compact Green Pea galaxies can host rapidly accreting supermassive black holes spanning a range of locations relative to the local black hole–host galaxy scaling relations. The proximity of J1622+3521 to the local relations may indicate that black hole growth and stellar mass assembly have remained broadly coupled in this system despite the ongoing interaction, although systematic uncertainties in both virial black hole masses and stellar-mass estimates should be kept in mind.

1.13 Comparison with Compact High-Redshift AGN

J1622+3521 shares several phenomenological similarities with compact high-redshift AGN populations. Both nuclei exhibit broad Balmer emission with FWHM ~ 1700 – 1900 km s^{-1} , compact morphology, and significant obscuration inferred from the X-ray spectral fitting. The measured column densities, $\log(N_{\text{H}}/\text{cm}^{-2}) \simeq 22.9$ for Source 1 and $\simeq 23.6$ for Source 2, indicate substantial nuclear obscuration in both systems. Such obscuration is qualitatively consistent with the dense gas-rich environments inferred for many compact AGN at high redshift, including Little Red Dot candidates identified with *JWST* [e.g., 107]. The stronger obscuration and redder optical colors of Source 2 are particularly noteworthy. Its large broad-line Balmer decrement and extinction estimate ($E(B - V)_{\text{BLR}} = 0.92 \pm 0.32$) resemble the reddened optical continua observed in some compact high-redshift AGN and Little Red Dot candidates, which have been interpreted as evidence for substantial dust obscuration and dense circumnuclear environments [e.g., 23–25]. At the same time, the spectral modeling does not require complete suppression of the nuclear X-ray emission, despite the substantial obscuration. In this sense, Source 2 may resemble transitional systems such as the X-ray Dot presented by [93], which exhibits several classical Little Red Dot spectral properties while simultaneously hosting luminous X-ray emission.

The relative weakness of broad $\text{H}\beta$ compared to broad $\text{H}\alpha$ is also consistent with partially obscured broad-line region emission. Similar Balmer-line properties are observed in Type 1.9 AGN [e.g., 94] and have recently been reported in several compact broad-line AGN identified with *JWST* at high redshift [e.g., 108], further strengthening the connection between J1622+3521 and rapidly growing supermassive black holes in dense, obscured environments.

Recent *JWST* observations have identified a population of compact broad-line AGN known as “Little Blue Dots”, which share many of the structural and spectroscopic characteristics of Little Red Dots but exhibit substantially bluer continua [33]. In several respects, J1622+3521 may more closely resemble these systems than classical Little Red Dot candidates. Indeed, preliminary work (Maillard et al., in preparation) suggests that some local compact star-forming galaxies [5] may occupy a similar photometric parameter space to Little Blue Dots, potentially strengthening the connection between AGN-hosting Green Pea galaxies and compact AGN populations identified at high redshift.

The comparison with local Green Pea AGN analogs is also informative. Green Pea galaxies are compact, low-metallicity star-forming systems believed to represent nearby analogs of galaxies during the epoch of reionization. Recent X-ray studies have revealed evidence for obscured AGN activity in at least some Green Pea galaxies, including luminous hard X-ray emission and moderate nuclear obscuration [e.g., 12, 64]. J1622+3521 extends this connection further by demonstrating that dual supermassive black hole growth can occur within such compact star-forming environments.

We additionally compare J1622+3521 with compact AGN populations identified at high redshift using the broad $H\alpha$ -X-ray plane shown in Figure 7. While many compact AGN candidates discovered with *JWST* appear X-ray weak relative to their optical or bolometric luminosities [e.g., 109, 110], both nuclei in J1622+3521 remain broadly consistent with the local broad-line AGN relation of [94]. In this respect, J1622+3521 more closely resembles the X-ray Dot [93] than the majority of currently known X-ray-weak compact AGN. If systems such as the X-ray Dot indeed represent a transitional phase between heavily embedded compact AGN and unobscured broad-line AGN, then J1622+3521 may provide a nearby example of a related evolutionary stage in which the central engine is already visible in both the optical and X-ray bands despite the presence of substantial nuclear obscuration.

The good agreement between the observed He II and soft X-ray luminosities and the empirical AGN relation of [92] further supports this interpretation. Despite the optical reddening and obscuration, both nuclei follow the same narrow-line region ionization scaling relations observed in classical AGN. Unlike many currently known Little Red Dot candidates, which are frequently X-ray weak or X-ray undetected, both nuclei in J1622+3521 are detected by *Chandra* and exhibit intrinsic luminosities consistent with AGN activity. While the spectral modeling favors moderate-to-high obscuration, the present data cannot completely exclude more heavily obscured geometries in which a fraction of the observed X-ray emission arises from scattered or reflected light. Future hard X-ray observations will be important for constraining the presence of any deeply buried AGN components.

Overall, J1622+3521 strengthens the growing connection between compact low-redshift AGN, Green Pea galaxies, and rapidly accreting supermassive black holes observed at high redshift. The ongoing interaction likely plays an important role in driving gas toward the nuclear regions, thereby fueling the AGN activity and contributing to the observed obscuration. The system therefore provides a valuable nearby laboratory for understanding how mergers, compact star-forming environments, and obscured accretion contribute to rapid supermassive black hole growth across cosmic time.

Acknowledgements

K.K. acknowledges support from the institutional project RVO:67985815 and from the INTER-COST LUC24023 project of the INTER-EXCELLENCE II programme funded by the Czech Ministry of Education, Youth and Sports. J.S. acknowledges support from the Czech Science Foundation (GAČR) project 26-22614S. The work of DS was carried

Table 2 Best-fit emission-line measurements from the Sherpa spectral decomposition for Source 1 and Source 2. Quoted widths correspond to FWHM velocities derived from the Gaussian fits. Luminosities are computed from the measured integrated line fluxes assuming $z = 0.2665$. The [O III] line fluxes correspond to the sum of the three Gaussian components used to reproduce the asymmetric emission-line profiles.

Spectrum	Emission Line	Flux (10^{-15} erg s $^{-1}$ cm $^{-2}$)	FWHM (km s $^{-1}$)	Luminosity (10^{41} erg s $^{-1}$)
Source 1				
Source 1	H α (narrow)	4.78 ± 0.19	328 ± 12	6.33 ± 0.25
Source 1	H α (broad)	2.06 ± 0.13	1892 ± 57	2.73 ± 0.18
Source 1	[N II] $\lambda 6583$	2.86 ± 0.11	328 ± 12	3.79 ± 0.15
Source 1	H β (narrow)	1.34 ± 0.03	190 ± 15	1.78 ± 0.04
Source 1	H β (broad)	0.31 ± 0.05	1200 ± 350	0.41 ± 0.06
Source 1	[O III] $\lambda 4959$ (total)	3.23 ± 0.49	323 ± 10	4.29 ± 0.65
Source 1	[O III] $\lambda 5007$ (total)	9.68 ± 1.45	323 ± 10	12.87 ± 1.93
Source 1	He II $\lambda 4686$	0.26 ± 0.01	309 ± 10	0.34 ± 0.01
Source 2				
Source 2	H α (narrow)	2.97 ± 0.25	579 ± 46	3.94 ± 0.33
Source 2	H α (broad)	1.76 ± 0.05	1690 ± 34	2.34 ± 0.06
Source 2	[N II] $\lambda 6583$	1.78 ± 0.15	579 ± 46	2.37 ± 0.20
Source 2	H β (narrow)	0.32 ± 0.02	175 ± 20	0.42 ± 0.02
Source 2	H β (broad)	0.19 ± 0.03	1000 ± 300	0.26 ± 0.04
Source 2	[O III] $\lambda 4959$ (total)	0.72 ± 0.06	396 ± 27	0.96 ± 0.08
Source 2	[O III] $\lambda 5007$ (total)	2.17 ± 0.17	396 ± 27	2.88 ± 0.22
Source 2	He II $\lambda 4686$	0.08 ± 0.01	309 ± 29	0.10 ± 0.01

out at the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration (80NM0018D0004). This research has made use of the Keck Observatory Archive (KOA), which is operated by the W. M. Keck Observatory and the NASA Exoplanet Science Institute under contract with the National Aeronautics and Space Administration. This research has made use of the NASA/IPAC Extragalactic Database (NED), which is funded by the National Aeronautics and Space Administration and operated by the California Institute of Technology. This research has made use of NASA’s Astrophysics Data System Bibliographic Services. This research has made use of the SIMBAD database, operated at CDS, Strasbourg, France. This work made extensive use of the Python packages NumPy, Matplotlib, SciPy, and Astropy.

Author contributions

K.K. coordinated observations, performed the optical and multiwavelength analyses, and led the interpretation of the results and writing of the manuscript. P.B. performed the X-ray spectral analysis, developed the corresponding methodology, and contributed to the interpretation of the results and writing of the manuscript. J.S.

and M.G. performed independent X-ray spectral-fitting tests and contributed to the interpretation of the X-ray results. D.S. and P.B. carried out the Keck/DEIMOS observations. K.K., P.B., J.S., A.B., and A.Z. contributed to the preparation of the *Chandra* observing proposal. All authors contributed to the interpretation of the results and commented on the manuscript.

Competing interests

The authors declare no competing interests.

Data availability

The *Chandra* observations analysed in this study are publicly available through the Chandra Data Archive under Observation IDs 28142, 30637, and 30638. The Sloan Digital Sky Survey (SDSS) and DESI Legacy Imaging Surveys (DECaLS) data used in this work are publicly available through their respective archives. The Keck/DEIMOS observations are available through the Keck Observatory Archive (KOA). Derived data products generated during this study are available from the corresponding authors upon reasonable request.

Code availability

This study made use of publicly available software, including CIAO, Sherpa, PyEIT, FADO, BXA, XSPEC/PyXspec, Astropy, SciPy, NumPy, and Matplotlib. Custom scripts used for data reduction, analysis, and figure production are available from the corresponding authors upon reasonable request.

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