Relativistic plasma as the source of variable optical continuum emission in broad-line radio galaxies

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The localization of the region of variable continuum emission, and hence of a broad-line region, is not well understood in radio-loud AGN because of complex structure of their nuclear regions. In radio galaxies, continuum emission from the relativistic jet can dominate at all energies, swamping emission originated in other central regions. A link between optical and radio emission is evidenced from the VLBI-optical monitoring of individual radio galaxies (3C 390.3 and 3C 120) covering the time period of 14 years. We found a correlation between the formation of new bright knots in the jet and the variable optical continuum emission in both radio galaxies. We interpret this correlation as evidence for the non-thermal optical flares being generated in the inner jet. Evidence for non-virial motions in the broad-line region and its implications in radio-loud AGN will be discussed.

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X-rays as a tool for disentangling nuclear activity from star formation processes

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The circum-nuclear regions of active galaxies hold fundamental information concerning the relationships existing among AGN and their hosts. Unfortunately, the simultaneous study of an AGN and its close environment is not straightforward, because, when the central source is directly observed, its extreme luminosity dominates the emission, suppressing the signals originated from neighboring regions. As a consequence, the best opportunity to investigate such environment comes from those cases where the strong continuum of the central engine is shielded by the intrinsic structure of the AGN and we are able to observe the host very close to the nucleus, as it happens in the case of type 2 objects. Optical spectroscopy shows that the circum-nuclear regions of active galaxies have signicantly different physical properties than those inferred for the same environment of the other systems. Indeed, while the spectral continuum close to the nucleus of a normal galaxy can be easily identied with that of an old, evolved stellar population, the stellar components of Seyfert 2 spectra show clear signatures of younger stars, with a systematically smaller continuum break at 4000 Å, indicating an excess of the spectral class A. The existence of hot stars in the nuclear environment leads us to conclude that a relatively recent star formation event must have occurred. On the other hand, the analysis of chemical abundances in the interstellar medium (ISM) found in these galaxies provides further suggestive indications. Several techniques, exploited to estimate the chemical composition of the Narrow Line Region (NLR), agree on the conclusion that heavy elements are more abundant in gas ionized by an AGN than in the nuclear regions of galaxies involved in ongoing star formation processes. The ISM of active galaxies, therefore, is evolved with respect to the case of star forming galaxies. Put together, all these hints place the circum-nuclear regions of active galaxies somewhere between the properties of normal galaxies, hosting an evolved stellar population, and those of galaxies where star formation occurred recently, as pointed out by the properties of their gaseous and stellar components. These results were veried on a large sample of spectra, covering the nuclear regions of galaxies with

redshift $z \leq 0.1$, collected at the public archive of the Sloan Digital Sky Survey (SDSS). Taking into account the limits imposed by the survey, whose observations are mainly concerned with the use of a xed aperture and a well established ux limit, it can be estimated that the physical properties found in the circum-nuclear regions of the observed galaxies are not signicantly affected by selection effects or by the distance dependence of the spectral sampling region and that they are an actual characteristic of the different object classes. A natural question, arising from the indications of recent star formation history in the nuclei of active galaxies, concerns whether star formation and AGN activity might be regarded, at least in some cases, as subsequent stages of an evolutionary sequence. As soon as the accreting black hole paradigm was established, together with the increasing evidence that every galaxy hosts a Super Massive Black Hole (SMBH) in its center, it has been argued that dynamic perturbations of the circum-nuclear environment are required to transfer matter towards the central engine. However, the processes which imply a perturbation of the circum-nuclear environment can either directly descend from star formation or they are at least very likely to enhance it, in agreement with the observational result. In order to further investigate the connection among AGN and star formation activity, we started a search for objects where the signature of nuclear activity might be hidden behind an ongoing process of star formation. Taking advantage from the recent technological achievements, that opened new frontiers in the amount and quality of the available data in several frequency ranges, it has now become possible to investigate the physics of galactic nuclei with unprecedented detail. The advance is particularly relevant in the eld of high energy signals, a distinguishing feature of AGN, since modern observatories are becoming able to trace direct hints of nuclear activity even in those cases where their typical signatures are suppressed by heavy absorption in the source. As a consequence of the small interaction cross section of photons with energy $E \leq 10$ keV, indeed, the most energetic tail of the intense AGN radiation eld might be able to penetrate the obscuring structures, which could prevent us from detecting the source at lower frequencies. Comparing our sample with the most recent catalogues of data released in the domain of X-rays, mainly by the XMM Newton satellite, but also taking observations from other missions, such as Chandra, we found out that various sources were detected in the energy range of hard X-rays. The largest number of detections, yielding 54 objects belonging to the Seyfert 2 class out of 2138 candidates, came from the sample of active galaxies. However, high energy activity was spotted in star forming galaxies, too, though with a smaller incidence of 16 detections out of 1302 candidates. The purpose of our project is to look for signatures connected with the presence of an active nucleus, hidden in the optical by the effects of surrounding star formation, in the range of high energy emission. At present, large amounts of archival material are becoming available to the scientic community, which could be of fundamental importance for this research, and more promising perspectives are developing thanks to the forthcoming observations. In order to identify hidden AGN activity and to provide a reliable distinction from external factors, such as the evolutionary processes of young stellar populations in the circum-nuclear region, which may also give raise to X-ray emissions, we looked at the X-ray properties of AGN affected by increasing amounts of obscuration. We exploited the Lipovetskys Catalogue of Seyfert Galaxies to select a reference sample. Applying the constraint $z \leq 0.1$, we found 121 Seyfert 1 galaxies detected as X-ray sources, with 29 having SDSS optical spectra in addition. Furthermore, 105 Seyfert 2 galaxies were recorded, with 27 providing additional SDSS spectra, while 43 lower ionization objects (LINERs) are detected as X-ray sources, out of which 2 have optical data available as well. In conclusion, it is our aim to develop a comparative analysis of objects where both optical and high energy observations are either available, or in the range of modern instruments technical capabilities. Looking at the main features which characterize the electro-magnetic emission of AGN in the domain of high energy signals, we shall probe the core of star forming galaxies, detected as X-ray sources, to clarify the origin of this radiation. The spectral energy distributions observed at these frequencies are starting to yield suggestive indications concerning the presence of nuclear activity, thus leading us to identify objects where the circum-nuclear star formation process may coexist with an AGN phase, possibly concealing its characteristic signatures in the optical spectrum.