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Contributed Papers for JD11: Abstracts

The Dynamical Evolution of Globular Clusters in the Galaxy

Zhen-yu Wu & Cheng-gang Shu (National Astronomical Observatories, Chinese Academy of Sciences)

Abstract. Given various initial conditions, the dynamical evolution of globular clusters in our Galaxy is investigated in detail by means of Monte Carlo simulations. Four dynamic mechanisms in the present paper are considered. They are the stellar evaporation in the tidal field, the stellar evolution during the early evolutionary stage, the tidal shocks due to clusters passing through the bulge and disk, and the dynamical friction. Comparing with the current observations, which include the number density distribution in space, mass function, etc., the so-called standard modes for both the power law and Gaussian cluster initial mass functions are selected among many runs of simulations. The deviation from the standard modes, which is resulted from the change of the parameter for the initial conditions, is discussed in detail. The discussion of the model parameters is also presented although they are adopted as the typical values based on previous work. Based on our simulations, some relevant discussions about the mass contributions to the Galactic central region and stars in the halo due to the dynamic evolution of globular clusters are also qualitatively presented.

A Hybrid Monte Carlo Tool to Simulate Dense Stellar Systems

Mirek Giersz, Rainer Spurzem & Doug Lin (Nicolaus Copernicus Astronomical Center, Polish Academy of Sciences)

Abstract. Spherically symmetric star clusters containing a large amount of primordial binaries or planetary systems are studied using a hybrid method, consisting of a gas dynamical model for the single stars and a Monte Carlo treatment for relaxation of binaries and their interactions with other stars and binaries. Each binary encounter is investigated by means of a highly accurate direct few-body integrator (adopted from NBODY6++). The evolution of individual binary and planetary orbital parameters can be directly followed and the cross sections for interesting physical processes involved binaries can be computed. Cross sections are obtained from a sampling of several hundred thousands of scattering events as they occur in a real cluster evolution including mass segregation of binaries, gravothermal collapse and re-expansion, binary burning phase and gravothermal oscillations. For the first time we are able to present empirical cross sections for eccentricity variation of binaries in close three- and four-body encounters. It is found that a large fraction of four-body encounters results in merging. We are also able, for the first time, to follow the changes of orbital parameters of primordial planetary systems in the course of cluster evolution.

General Solution for Hydrodynamical Equations

Saeed Otarod & Jamshid Ghanbari (Razi University)

Abstract. We will apply a new mathematical method (introduced by the authors) to solve the nonlinear hydrodynamical equations Governing the opti-

cally thin interstellar media in one dimension. Although a simple example have been chosen, But it is very instructive. In this simple example we will discuss about cases that we way substitute an ordinary equation for continuity equation. we also will prove that the same can be done to equation of motion and energy equation. As a conclusion we will show that the results of this research can have a wide application in all areas of Physics and nonlinear mathematics. It seems that in many cases we are not obliged to make use of numerical calculations and a great number of nonlinear important physical equations can be solved analytically in their most general form.

Dynamical Friction on Star Clusters Near the Galactic Center

Sungsoo Kim & Mark Morris (Kyung Hee University, Korea)

Abstract. Numerical simulations of the dynamical friction suffered by a star cluster near the Galactic center have been performed with a parallelized tree code. Gerhard (2001, ApJ, 546, 39) has suggested that dynamical friction, which causes a cluster to lose orbital energy and spiral in towards the galactic center, may explain the presence of a cluster of very young stars in the central parsec, where star formation might be prohibitively difficult owing to strong tidal forces. The clusters modeled in our simulations have an initial total mass of 10^5-10^6 $M_\odot$ and initial galacto-centric radii of 2.5-30 pc. We have identified a few simulations in which dynamical friction indeed brings a cluster to the central parsec, although this is only possible if the cluster is either very massive ($\sim 10^6$ $M_\odot$), or is formed near the central parsec (greater than about 5 pc). In both cases, the cluster should have an initially very dense core (10^6 $M_\odot$ pc^{-3}). The initial segregation of massive stars into the cluster core can help achieve the requisite density, and can help account for the observed distribution of HeI stars in the central parsec.

Distribution, Orbits and Dynamics of Globular Clusters

Hongnan Zhou & Keliang Huang (Physics Dept. of Nanjing Normal University, Nanjing, China)

Abstract. We have compiled a sample of the 29 F globular clusters from Harris's Catalog of parameters for Milky Way globular clusters (1999) and other sources. According to the azimuth coordinates, distances from Sun, radial velocities and proper motions of the sample clusters, we have integrated orbits assuming three different galactic potential models and have calculated orbital parameters. The uncertainties associated with the orbital parameters are produced by Monte Carlo simulation, the relationship between the distributive morphologies of the orbital parameters and the initial observational errors as well as the different galactic potential models are discussed. We investigate the effect of the orbital motion on the internal dynamics of clusters samples, the results of our investigation show that the two-body relaxation is more important than tidal shocking.

Diagnostics of Accretion Disc in AGN

Surendra Nath Borah & Hira Lal Duorah (DKD College & Dergaon)

Abstract. The active galactic nuclei (AGN) are the most luminous objects in the universe. Total power radiated by an AGN is greater than the total

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power emitted by all the stars in the host galaxy.The direct diagnostics of the conditions within AGNs come from radiations produced by a wide variety of mechanisms including high energy gamma ray processes, atmospheric re processing, dust emissions, and synchrotron radiation. In addition to optical and X-ray photons,the emission includes MeV, GeV and also TeV gamma rays. We have considered that AGNs are powered by an accretion disc around a supermassive black hole of 10^{08} solar mass. The structure and heights from the central plane of an accretion disc around such a black hole depends on the composition of disc material,accretion rate, self gravity,and magnetic field in the accreting material. We have considered three types of composition of the disc material: 1. X= 0.600; Y= 0.380; Z= 0.020, 2. X= 0.700; Y= 0.280; Z= 0.020, 3. X= 0..800; Y= 0.199; Z= 0.001, X,Y,and Z represent hydrogen,helium and metal abundances respectively and the three accretion rates are 0.01,0.001, 0.005 solar mass per year respectively. The result shows that the disc height decreases as the accretion rate decreases.

Towards the Formation Problem of Dense Stellar Systems

S. Nuritdinov & K. Mirtadjieva (Astron. Department, National University of Uzbekistan)

Abstract. Two possible formation models of dense stellar systems (DSS) are considered. According to one of these models cold initial conditions can stimulate a collapse and bring to the DSS at least in central region of the system. The stability problem of the collapse is also studied. New asymptotic unknown in cosmology is found. In the frame of other model it is revealed the regions on the diagram "virial ratio - rotation parameter", which are connected with the formation of the DSS.

Close Encounters and a Black Hole in the Globular Clusters

Abdikul Ashurov (Ulugh Beg Astronomical Institute of the Uzbek Academy of Sciences)

Abstract. It is known that the presence of a black hole in the globular cluster (GC) affects the stellar density profile and the central stellar dynamics. In this paper a problem of the dynamical evolution under close encounters in the GC, where a black hole is present, is considered. Since the evolution temp depends on the rate of the stellar encounters, an exact expression for the probability of encounters with given changes of energy integral and angular momentum per unit mass is determined assuming an anisotropic field star distribution function. It is used as a core of the collisional term of the Boltzman's equation. A behavior of the probability density in a globular cluster with and without a black hole has been studied for Plummer and King-Michie models in the isotropic and anisotropic cases. Because of this method takes weak as well as close encounters into account, it is more general method than Fokker-Planck one.

Massive Star Cluster Birth and the Morphology of Galaxies

Pavel Kroupa (University of Kiel)

Abstract. Most stars form in embedded star clusters with low star formation efficiencies. When the gas is expelled a large fraction of the stellar population expands outwards into the field of the host galaxy. The implications this process

has on the morphological appearance of galaxies will be addressed using the example of thickened galactic disks.

The Masses and Stellar Content of Nuclear Star Clusters

Luis Ho (Carnegie Observatories)

Abstract. Central nuclear star clusters are very common in late-type spiral galaxies; approximately80contain such clusters. Central star clusters may be related to the formation of seed massive black holes and the secular build up of bulges. However, very little is known about their physical properties, including their ages, chemical composition, and mass. We present deep high-resolution spectra of nuclear star clusters to determine their internal velocity dispersions and virial masses, and medium-resolution spectra to determine their stellar ages and metallicities. These fundamental parameters will help elucidate the nature of these objects and their relation to the global evolution of galaxies.

The Initial Mass Function of Star Cluster Systems

Uta Fritze - v. Alvensleben, Richard De Grijs & Peter Anders (Universitaetssternwarte Gö ttingen, Germany)

Abstract. It is well-established that the Globular Cluster (GC) System of the Milky Way has lost about 50population over a Hubble time. Details about the initial distributions of GC masses, concentrations, metallicities, positions and orbits are difficult to reconstruct. Since star cluster formation appears to be the dominant mode of star formation in massive interacting gas-rich starburst galaxies, this allows us to at least assess the initial Mass Function (MF) of such star cluster systems "observationally". Luminosity functions are strongly distorted with respect to MFs due to age-spread effects in combination with strongly age-dependent M/L-ratios for young star clusters. Hence, we developed techniques to independently determine individual cluster ages, metallicities, and extinctions from a UV-optical-NIR comparison of model and observed spectral energy distributions, from our ASTROVIRTEL-project (European HST archive research). Initial star cluster MFs and MFs for cluster systems of older ages are presented. We anticipate that our results will provide valuable input and boundary conditions for dynamical GC evolution and destruction models.

Radiation-Hydrodynamic Formation of Massive Black Hole

Nozomu Kawakatu & Masayuki Umemura (Center for Computational Physics, University of Tsukuba)

Abstract. A novel mechanism to build up a massive black hole is proposed based on the relativistic radiation-hydrodynamic model. In the present scenario, the mass of a black hole is predicted to be in proportion to the bulge mass, and it is found that the BH-to-Bulge mass ratio is basically determined by the nuclear energy conversion efficiency from hydrogen to helium(=0.007). Also, we find that the radiation drag works effectively in forming a BH even in a small spheroidal system, but the mass of BH in globular cluster is closely related to its star

formation history. In addition, we reveal relationship between the morphology of galaxy and the mass of black hole.

Morphology of Galactic Open Clusters

Chin-wei Chen & Wen-ping Chen (Graduate institute of Astronomy, National Central University)

Abstract. Thirty six open clusters were selected from the 2MASS database on the basis of the latest open cluster catalogue (Dias et al. 2002, A&A, 389, 871). The morphological parameters such as eccentricity, orientation were obtained via isodensity elliptic fitting. Most star clusters are elongated, and the eccentricity is correlated with z as an indication of the influence of the Galactic disk. The morphology shows clear evidence of competing internal dynamics and external Galactic disturbances when a cluster becomes 10 Myr old.

The Initial Violent Dynamics of Globular Clusters

Paolo Miocchi & Roberto Capuzzo Dolcetta (Universita' di Roma, Dipartimento di Fisica)

Abstract. In order to investigate some relevant aspects of globular clusters formation, we studied numerically the dynamics of a self-gravitating stellar system of the size of a typical globular cluster, starting from non-equilibrium and 'cold' initial conditions. Such conditions are, indeed, those expected after the formation of the stellar system, i.e. after the complete exhaustion of primordial gas through the gas-star phase transition which occurred on the star-formation time scale. Our (preliminary) results allow to draw some meaningful conclusions about the evolution of the distribution function toward a meta-stable state, by mean of the quick 'violent relaxation' of the whole system (core formation, mass segregation, anisotropy...). To this virialized state follows the, well known, further evolution caused by star-star encounters. We underline that the initial 'violent' dynamics can be well investigated by mean of codes (like our own tree-code) which are efficient in the representation of the time evolution driven by the quick mean-field variations, even if the individual 2-body close interactions (which are not really relevant in this phase) are not followed in detail.

Globular Cluster Merging in the Inner Galactic Region

Roberto A. Capuzzo-Dolcetta, Paola Di Matteo and Stefano Paolini (Dep. of Physics, University of Roma La Sapienza)

Abstract. The dynamics of the encounter of two globular clusters, made up of 10^5 stars each, in the bulge of an elliptical galaxy, has been followed up to 15 orbital periods ($1.7*10^7$ years) by mean of a direct summation code. Aim of these simulations is to understand whether the merging of a group of globular clusters in a unique stellar system is possible in the central regions of galaxies, before the strong coupled bulge-nucleus [Image] tidal actions destroy them. As a matter of fact, three dynamical mechanisms act in competition during the merging of two globular clusters. The galactic tidal action tends, on one side, to break up clusters before they form a unique self-gravitating system; on the other side, the same tidal force has also the effect to convert translational kinetic energy into internal random motion, thus leading, slowly, clusters to inner

galactic regions. Additionally, the dynamical friction caused by the stellar field decelerates significantly the cluster orbital decay. Due to the non-linearity of the interactions among these mechanisms, reliable results can be achieved just via detailed numerical simulations, as those we present here.

Statistical Study of Blue Straggler Properties in GGC

Francesca De Angeli & Giampaolo Piotto (Astronomy Department of Padova University)

Abstract. In this poster we report on the most significant results from a statistical analysis of the main properties of globular cluster blue straggler stars (BSS) extracted from the HST snapshot database of photometrically homogeneous color-magnitude diagrams (Piotto et al. 2002). The BSS relative frequency presents a significant anticorrelation with the collisional rate and with the cluster total absolute luminosity.

Dynamical Friction Acting on a Dissolving Globular Cluster

Michael Fellhauer (Institut für Theoretische Physik und Astrophysik)

Abstract. We want to investigate with high-resolution N-body calculations the strength of the dynamical friction acting on a globular cluster sinking into the dense center of the Milky Way. On its way to the center of the Galaxy the cluster looses mass efficiently due to tidal forces and it is still unclear how this mass-loss affects the time-scale of dynamical friction. The ultimate aim of this study is to investigate if and how quickly globular clusters sink to the center of the Milky Way and deposit their stars there.

Blue Stragglers in M67: Evidence of Primordial Triples?

Ludmila Kiseleva-Eggleton & Peter Eggleton (St. Mary's College of California)

Abstract. At present there are between 18 and 40 (depending on the criteria used) identified blue stragglers (BS hereafter) in M67. Among these BSs are single stars, single-lined (SB1 hereafter) and double-lined spectroscopic binaries, eclipsing binaries and even a triple system S1082. There are three main channels that allow binaries to produce BSs: (*i*) very close binaries → semi-detached binaries → contact binaries → merger into a single star; (*ii*) moderately close binaries → semi-detached binaries (Algols) → post-Algols; (*iii*) collision of the components of a close binary, when perturbed dynamically by another star or binary. The first and second can produce binary BSs, and the first and third can produce single BSs. EV Cnc (S1036) - a BS eclipse - looks like a good example of channel (i), part-way through the contact phase and heading for a merger. Unfortunately the eclipses are shallow, and so it is hard to analyze definitively, e.g. whether it is in contact, semi-detached or even detached. The same mechanism might account for some single BSs as well. We should probably expect comparable numbers, as the merger time scale is roughly the magnetic-braking time scale, and this appears to be comparable to the nuclear time scale at these low masses. S1284 (a sort-period SB1 with $P = 4.2$d, $e = 0.26$) is a possible candidate for channel (ii), although the eccentricity is remarkable. Perhaps it suffered a moderate dynamical encounter that de-cirularized the orbit once mass transfer was finished. Four known SB1s have $P \sim 850 - 5000$d. It is hard to believe that these wider SB1s are the remains of mass transfer. We expect very

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non-conservative Roche-lobe overflow (RLOF) in the wider binaries, so that the gainer is not able to become very much bluer than the loser was originally. At $P \sim 3000 - 5000$d we expect little or no mass transfer. The mechanism of dynamically-forced collisions with mergers seems the most promising (or least unpromising) for such systems. But it means presumably that the BSs which are now wide SB1s were **previously triple**. One BS (S1082) is currently triple; not only that but *two* of the three components are BSs! Perhaps what we need in this case is a collision between two triples. The close pair in each was forced into collision, one star was ejected, and one of the two third bodies remained in a fairly close orbit around one of the merged pairs. Although triples can be produced in a cluster by dynamical interactions, such triples usually are destroyed again later. We need a population of **primordial triples**, where the outer orbit is sufficiently small ($\sim 1 - 30$yr) that the triple can survive a long time. Such systems constitute $1 - 3\%$ of the solar neighborhood. This does not seem enough to have much influence in producing BSs. But triples ought to tend to migrate towards the center of a cluster and so should be particularly prone to interact with binaries and with each other. They also have larger interaction cross-sections.

An N-Body Model of the Hyades

Søren Madsen (Lund Observatory)

Abstract. The three-dimensional structure and kinematics of the Hyades cluster as seen by Hipparcos are compared with realistic N-body simulations using the NBODY6 code. Stars are selected from the model in a way that resembles the Hipparcos observations of the cluster. Attempts to detect a correlation between the velocity dispersion and cluster radius or stellar mass using observational data from the Hipparcos and Tycho-2 Catalogues are inconclusive, but the fit of the N-body model to the observations of the cluster structure indicates that the current cluster velocity dispersion decreases from 0.35 km/s at the cluster center to a minimum of 0.20 km/s at 8 pc radius (2-3 core radii), from where it slightly increases outwards. A clear negative correlation between dispersion and stellar mass is seen in the central part of the cluster but is almost absent beyond a radius of 3 pc. With GAIA astrometry it will be possible to investigate the structure, velocity field, IMF, binary properties etc. of the entire entire Hyades (excluding sub-stellar objects). This detailed dynamical knowledge suggests that the Hyades can be used as a calibrator for N-body models in the future.

An Overview (Introductory Notes on Dense Stellar Systems)

Rainer Spurzem (Astronomisches Rechen-Institut)

Abstract. An Overview on Dense Stellar Systems is given - relevant time scales for young massive or old globular star clusters are reviewed and compared to the different conditions in dense galactic nuclei, possibly with one or more massive black holes. It is discussed, how our physical knowledge depends on the advancement of computing and simulation techniques and the underlying physical methods. Different methods, such as direct N-body, gaseous or Fokker-

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Planck models are discussed and compared and recent theoretical developments are highlighted.

The Wake of a Body Moving Through a Stellar Distribution

Winston L. Sweatman & Douglas C. Heggie (Massey University)

Abstract. We calculate the change in density within a uniform distribution of field stars which is caused by a dense body plunging through with a constant velocity. Starting with the simplest case in which the field stars are initially stationary this leads to an infinite density along the axis of the wake. Introducing a small thermalisation within the field stars removes this infinity whilst leading to similar results off the path of the dense body. Results are in good agreement with those previously derived. A uniform approximation can be made for the density in the thermalized case and this can be used to deduce the force exerted on the moving star due to the drag caused by the accretion wake.

The Mass Function of Galactic Clusters and its Evolution

Guido De Marchi (European Space Agency)

Abstract. We show that we can obtain a good fit to the main sequence mass functions of a large sample of Galactic clusters (young and old) with a tapered Salpeter power law distribution function with an exponential truncation. The average value of the power-law index is very close to Salpeter (2.3), whereas the peak mass is in the range 0.1-0.5 Msolar and does not seem to vary in a systematic way with the present cluster parameters such as metal abundance and central concentration. A remarkable correlation with age, however, is seen in that older disc clusters have higher peak mass, although this trend does not extend to globular clusters, whose peak mass is lower than that of old disc clusters. We attribute this trend to the onset of mass segregation following early dynamical interactions in the loose cluster cores. Differences between globular and younger clusters may depend on the initial environment of star formation, which in turn affects their total mass. Mass functions of field populations such as the solar neighborhood and Galactic bulge are consistent with the hypothesis that they were built up over time by contributions from many functions of this type with different peak masses.

Density Waves in Gaseous Mini-Disks of NGC 4501 and NGC6951

Natalia Orlova, Vladimir Korchagin, Aleksei Moiseev, & Christian Theis (Institute of Physics, Rostov State University)

Abstract. We studied the gaseous mini-disks of the central regions of NGC 4501 and NGC 6951. Taking into account the observed properties of the molecular gas in the central region we built equilibrium models for both galaxies. These models are characterized by a gas-rich, self-gravitating central region which is close to marginal stability measured by the Toomre parameter Q. The minimum Q-values are 1.2 and 0.8 for NGC 4501 and NGC 6951, respectively. In agreement with the expectation from linear analysis, our hydrodynamical simulations showed that both mini-disks are gravitationally unstable. Moreover, different to extended galactic disks multi-armed modes are dominant instead of low-m

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modes. This yields in a flocculent morphology which is in good agreement with the observed structures for both galaxies.

The Survival of Substructure in Clumpy Clusters

Simon Goodwin & Anthony Whitworth (Cardiff University)

Abstract. Initially fractal star clusters undergo a dramatic phase of dynamical evolution. Significant amount of substructure can remain in the clusters, especially if the initial velocity field is correlated with the density structures. As observations show that many star clusters are born clumpy, simulations with smooth initial conditions may be missing an important phase of cluster evolution.

The Distribution of Stars in the Outer Part of Clusters

Kang Hwan Lee & Hyung Mok Lee (Astronomy Program, SEES, Seoul National University)

Abstract. We have performed N-body simulations to study the tidal tails of the Galactic globular clusters. The Galactic potential in our model is contributed by central bulge, outer halo, and exponential disk. These components are assumed to be invariant in time in the frame. We investigate the cluster of multi-mass models with a power-law initial mass functions starting with different initial masses, initial number of particles, and different galacto-centric distances as well as ellipticities of orbit. We have examined the general evolution of the clusters, the shape of outer parts of the clusters, density profiles and the direction of tidal tails. We also have performed the wide field CCD photometry of two Galactic globular clusters (M92 and NGC 7492) to examine the dynamical status of the clusters. The observations were made with the 3.6 m Canada-France-Hawaii Telescope (CFHT), using CFH12K camera. The effects of the dynamical evolution of the cluster have been investigated by means of a completeness-corrected luminosity function and mass function and radial density profile and surface density map.

Case C Mass Transfer in the Evolution of Black Hole Binaries

Chang-Hwan Lee & Gerald E. Brown (Pusan National University, Korea)

Abstract. Earlier works have shown that if the Fe core in a pre-supernova star is to be sufficiently massive to collapse into a black hole, earlier in the evolution of the star the He core must be covered (clothed) by a hydrogen envelope during He core burning and removed only following this, in, e.g. common envelope evolution. This is classified as Case C mass transfer. In this work we argue for Case C mass transfer on the basis of binary evolution. The giant progenitor of the black hole will have a large radius about 1000 solar radius at the end of its super-giant stage. Its lifetime at that point will be short, about 1000 yrs, so it will not expand much further. Thus, the initial giant radius for Case C mass transfer will be constrained to a narrow band about 1000 solar radius. This have the consequence that the final separation following common envelope evolution will depend nearly linearly on the mass of the companion which becomes the donor after the He core of the giant has collapsed into the black hole. We show

that the reconstructed pre-explosion separation of the black hole binaries fit well the linear relationship.

Nuclear Starbursts and AGN Evolution

Michael Dopita (Research School of Astronomy and Astrophysics, Aust. Nat. University)

Abstract. The environments of Active Galactic Nuclei (AGN) are often also the regions of greatest gas concentration and star formation in galaxies. The symbiotic relationship between the circum-nuclear gas, the associated star formation and the inflow, jets and photoionization associated with the AGN provides for very rich gas-phase physics. I will discuss some of these aspects insofar as they relate to the temporal evolution of both the nuclear star formation region and of the AGN.

Formation of Massive Black Holes Via IMBHs

Yoko Funato (University of Tokyo)

Abstract. We propose a possible way of forming massive black holes (MBHs) from stellar mass black holes (SBHs) through intermediate mass black holes (IMBHs). We assume that the SBHs can be formed from massive stars. Although this is possible, it was thought to be difficult that SBHs merge into massive black holes. When SBHs have to be born in a star cluster, they concentrate in the center of the cluster. After concentration, they cannot grow through merging since they are ejected the from the cluster due to sling shots. When the star cluster is enough large and the potential of the center of the cluster is enough deep to enclose SBHs, the SBHs cannot concentrate into the center for the largeness of the cluster. The situation seems a dead end for SBHs born in star clusters. However, the discovery of an IMBH in a star cluster in M82 suggests that there is a possible way to form a MBH from SBHs through IMBHs. Here we show that it is possible for the IMBHs born in star clusters to merge and to form a MBH from the point of view of dynamical evolution of star clusters in a host galaxy.

Evolution of Dense Star Clusters Near the Galactic Center

Steve McMillan & Simon Portegies Zwart (Drexel University)

Abstract. We use direct N-body simulations to study the internal evolution and orbital decay of dense star clusters near the Galactic center. These clusters sink toward the center due to dynamical friction with the stellar background, and may go into core collapse before being disrupted by the Galactic tidal field. Collisions in the collapsed cluster core may lead to the formation of a single super-massive star. When the cluster eventually dissolves, it may deposit the remnant of this super-massive star, as well as a disproportionately large number of other massive stars, within the innermost parsec of the Galactic nucleus. Comparing the results of N-body models to the observed spatial distribution

and kinematics of IRS16, a group of young He I stars near the Galactic center, we argue that this association may have formed in this way.

An Intermediate-Mass Black Hole in the Dwarf Galaxy Pox 52

Aaron Barth (California Institute of Technology)

Abstract. Do dwarf elliptical and dwarf spiral galaxies contain central black holes with masses below 10^6 solar masses? Beyond the Local Group, dynamical searches for black holes in this mass range are very difficult, but the detection of accretion-powered nuclear activity could be used to infer the presence of a black hole. The nearby dwarf spiral galaxy NGC 4395 hosts a faint Seyfert 1 nucleus with a likely black hole mass in the range 10^4-10^5 solar masses, and for more than a decade it has been the only known example of a Seyfert 1 nucleus in a dwarf galaxy. I will present new Keck spectra of the dwarf galaxy POX 52, which demonstrate that it has a Seyfert 1 spectrum nearly identical to that of NGC 4395. Its velocity dispersion is 37 km/s, suggesting a possible black hole mass of order 10^5 solar masses. I will discuss the prospects for systematic searches for nuclear activity in dwarf galaxies and the implications for black hole demographics.

Stellar Disc Near SgrA*-A Remnant of a Dense Accretion Disc

Yuri Levin & Andrei Beloborodov (CITA)

Abstract. We analyze recently measured 3-D velocities of massive stars in the Galactic center. We show that a thin disc of massive stars revolves around SgrA*, and we argue that these stars are a remnant of a dense accretion disc which existed a few million years ago.

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