Investigating Strangeness: from Accelerators to Compact Stellar Objects

Report of Contributions

https://agenda.infn.it/e/7929

Contribution ID: **0** Type: **not specified**

Can very compact and very massive neutron stars both exist?

The existence of neutron stars with masses of 2 solar masses requires a stiff equation of state at high densities. On the other hand, the necessary appearance also at high densities of new degrees of freedom, such as hyperons and ? resonances, can lead to a strong softening of the equation of state with resulting maximum masses of 1.5 solar masses and radii smaller than 10 km. Hints for the existence of compact stellar objects with very small radii have been found in recent statistical analysis of quiescent low-mass X-ray binaries in globular clusters. We propose an interpretation of these two apparently contradicting measurements, large masses and small radii, in terms of two separate families of compact stars: hadronic stars, whose equation of state is soft, can be very compact, while quark stars, whose equation of state is stiff, can be very massive. In this respect an early appearance of ? resonances is crucial to guarantee the stability of the branch of hadronic stars. Our proposal could be tested by measurements of radii with an error of 1 km, which is within reach of the planned LOFT satellite, and it would be further strengthened by the discovery of compact stars heavier than 2 solar masses.

Reference: A.D., A.Lavagno and G.Pagliara Phys.Rev. D89 (2014) 043014

Presenter: DRAGO, Alessandro (FE)

Track Classification: Part 2

Contribution ID: **1** Type: **not specified**

Y* resonances investigation originated in K-light nuclei absorption by AMADEUS

The AMADEUS experiment deals with the investigation of the low-energy
kaon-nuclei hadronic interaction at the DAΦNE collider at LNF-INFN, which is fundamental to solve longstanding questions in the non-perturbative strangeness QCD sector. AMADEUS step 0 consisted in the reanalysis of 2004/2005 KLOE data, exploiting K^- absorptions in H, ^4He, ^9Be and ^{12}C, leading to the first invariant mass spectroscopy study with in-flight negative kaons. With AMADEUS step 1 a dedicated pure Carbon target was implemented in the central region of the KLOE detector, providing a high statistic sample of pure at-rest K^- nuclear interaction.

We will show the results obtained in the analysis of the $\Sigma^+\pi^-$ and $\Sigma^0\pi^0$ (pure isospin 0) channels, intended to shed light on the controversial nature of the $\Lambda(1405)$ state. The analysis of the $\Lambda(\Sigma^0)\pi^-$ channel, from which the measurement of the module of the isospin 1, S-wave non resonant transition amplitude ca be extracted for the first time, will be presented.

Presenter: Mr PISCICCHIA, Kristian (LNF)

Contribution ID: **2** Type: **not specified**

Single vs multi nucleon absorption processes in low-energy K-nuclei interactions

One of the most interesting aspects of low energy QCD in a strangeness sector is to understand how hadron masses and interactions change in the nuclear environment. The antikaon-nucleon potential is investigated searching for signals from possible bound kaonic clusters. The existence of such objects is very debated, and it would open the possibility for the formation of very dense baryonic matter and imply a deep attractive antikaon-nucleon potential.
In our work, as a first step of the AMADEUS experiment, data from KLOE measurements (from 2004-2005) were used to study Λp, Λd and Λt correlations - channels expected to decay into K^-pp, K^-ppn and K^-ppnn clusters respectively. This channels give the opportunity to investigate single and multi-nucleon absorption processes, important for disentangling these processes from possible signal due to the formation of a bound state. Theoretical calculations are giving large range of values for the binding energy and the width of the predicted states, so more experimental data are needed to reveal this puzzle.

Presenter: TUCAKOVIC, Ivana (LNF)

Contribution ID: **3** Type: **not specified**

Anisotropic systems of Fermions: gravitational equilibrium and dynamic stability

Systems of selfgravitating Fermions constitute a topic of great interest in astrophysics, due to the wide range of applications, and are used also to explain dark matter in galaxies and clusters of galaxies. Here, we study the gravitational equilibrium of spherical models describing a semidegenerate collisionless gas. The Fermi-Dirac distribution function, modified by a cutoff term in order to avoid infinite solutions in mass and radius, is multiplied by an anisotropic term, depending on the angular momentum, evidencing the prevalence of tangential motion of the particles. The starting point is solving the equations of the gravitational equilibrium (both in Newtonian and General Relativistic regime) and analyzing the behavior of the matter density through the calculation of the components of the pressure tensor. We have extended the analysis in the classical regime and in the fully degenerate limit, considering also the problem of the dynamic stability. By solving the equation of the small oscillations for anisotropic systems, new expressions for the critical value of the polytropic exponent are derived, both in Newtonian and General Relativistic regime.

Contribution ID: **4** Type: **not specified**

Galaxy clusters in presence of dark energy

Dark energy, discovered by observations of the SN Ia at redshift $z<1$, affects the large scale stellar structures in the Universe, like the galaxy clusters. Being the observed velocities of the galaxies inside a cluster largely smaller than the light velocity, we can derive, and numerically solve, the gravitational equilibrium equation in presence of dark energy by considering the Newtonian regime. In the ΛCDM model, dark energy is identified by the Einstein Λ term with a constant energy density. The presence of dark energy in the gravitational equilibrium equation leads to wide regions in the gravity versus dark energy density diagram where the equilibrium solutions are not allowed, due to the prevalence of dark energy effects on the gravity. The improvement of the numerical calculations will allow us to compare the observational data of the galaxy clusters, present in the most important catalogues, with our theoretical model.

Contribution ID: **5** Type: **not specified**

Gravity and Thermodynamics. I. Fundamental principles

In the dynamical evolution of globular clusters, stellar encounters strongly contribute in phase space mixing of stellar orbits. In this scenario, thermodynamics plays a central role in the gravitational equilibrium and stability of the clusters. On the other hand, the observations of luminosity profiles suggest a unique distribution function allowing the study of the evolution as a sequence of thermodynamic transformations, keeping constant the distribution of the star velocities, like in the framework of Boltzmann statistical mechanics. Then, we can construct equilibrium models with a different approach by applying thermodynamic principles to a Boltzmann distribution function, with an Hamiltonian which contains an effective potential depending on the kinetic energy of the stars. We also obtain new relations for the thermodynamical equilibrium in presence of gravity and introduce the concept of thermodynamic and kinetic temperature and pressure. The models present regions with positive and negative specific heat, producing thermodynamic instabilities which drive the clusters towards the so called gravothermal catastrophe.

Contribution ID: **6** Type: **not specified**

Gravity and thermodynamics: a new point of view in the analysis of equilibrium and dynamical evolution of globular clusters.

In the analysis of the evolution of globular clusters, stellar encounters strongly contribute in phase space mixing of stellar orbits. In this scenario, thermodynamics plays a central role in the gravitational equilibrium and stability of the clusters, being binary relaxation time shorter than the age of such systems.
On the other hand, the observations of luminosity profiles of globular clusters, at different values of the central gravitational potential, show self similar curves that suggest a unique distribution function (King DF) with changing thermodynamical parameters during the dynamical evolution, according to the numerical simulations existing in literature. This means that the evolution of globular clusters can be studied by considering small thermodynamic transformations which keep constant the functional form of the velocity distribution of stars like in the framework of Boltzmann statistical mechanics.
We then construct King models with a different approach by applying thermodynamic principles to a Boltzmann distribution function with an Hamiltonian function which contains an effective potential depending on the kinetic energy of the stars. In this way, we obtain new relations for the thermodynamical equilibrium in presence of a gravitational potential, a different form of the virial theorem and introduce the concept of thermodynamical and kinetic temperature and pressure. We can also demonstrate that a globular cluster can be described as a Lynden-Bell model containing regions with positive and negative specific heat producing thermodynamic instabilities which drive the systems towards the so called gravothermal catastrophe, first described by Lynden-Bell and Wood in the well known paper in 1968.
The results, applied to the new Harris Catalogue for globular clusters, give an important agreement between theory and observations.

Presenter: Prof. MERAFINA, Marco (University of Rome La Sapienza)

Contribution ID: **7** Type: **not specified**

Welcome

Wednesday, 14 May 2014 09:00 (15 minutes)

Presenter: Dr CURCEANU, Catalina Oana (LNF)

Session Classification: Part 1

Contribution ID: **8** Type: **not specified**

kaonic atoms and nuclear clusters

Wednesday, 14 May 2014 09:30 (30 minutes)

In this talk I will review recent studies of kaonic atoms, few-body kaonic
quasibound states and kaonic nuclei, with emphasis on implementing the sub-threshold energy dependence of the Kbar-N interaction in chiral interaction models that are consistent with the SIDDHARTA kaonic hydrogen data. Remarks will be made on the possible role of the p-wave Sigma(1385) resonance with respect to that of the s-wave Lambda(1405) resonance in searches
for strange dibaryons

Presenter: Prof. GAL, Avraham (Hebrew University, Jerusalem)

Session Classification: Part 1

Contribution ID: **10** Type: **not specified**

Stangeness in compact stars

Wednesday, 14 May 2014 10:30 (30 minutes)

Presenter: BOMBACI, Ignazio (PI)

Session Classification: Part 1

Contribution ID: **12** Type: **not specified**

Toward a networking activity on strangeness and charm physics

Wednesday, 14 May 2014 09:15 (15 minutes)

An international network for HadronPhysics in Horizon is proposed to join groups working in studies on open issues in strangeness and charm physics. The network IMPACTs includes experimental and theoretical studies.
An overview of the research topics of IMPACTS will be given in the talk.

Presenter: Dr MARTON, Johann (Stefan Meyer Institute)

Session Classification: Part 1

Contribution ID: **13** Type: **not specified**

Possibility of light neutral hypernuclei with strangeness -1 and -2

Wednesday, 14 May 2014 10:00 (30 minutes)

Our current knowledge of the baryon−baryon interaction suggests that the dineutron (n,n) and its strange analogue (Lambda,N) are unstable. In contrast, the situation is more favourable for the strange three-body system (n,n,Lambda), and even better for the four-body system T=(n,n,Lambda,Lambda) with strangeness -2, which is more likely to be stable under spontaneous dissociation. This new nucleus could be produced and identified in central deuteron−deuteron collisions via reaction d+d -> T+K+K.

Presenter: RICHARD, Jean-Marc (IPNL)

Session Classification: Part 1

Contribution ID: **14** Type: **not specified**

Can very compact and very massive neutron stars both exist?

Wednesday, 14 May 2014 11:30 (30 minutes)

The existence of neutron stars with masses of 2 solar masses requires a stiff equation of state at high densities. On the other hand, the necessary appearance also at high densities of new degrees of freedom, such as hyperons and ? resonances, can lead to a strong softening of the equation of state with resulting maximum masses of 1.5 solar masses and radii smaller than 10 km. Hints for the existence of compact stellar objects with very small radii have been found in recent statistical analysis of quiescent low-mass X-ray binaries in globular clusters. We propose an interpretation of these two apparently contradicting measurements, large masses and small radii, in terms of two separate families of compact stars: hadronic stars, whose equation of state is soft, can be very compact, while quark stars, whose equation of state is stiff, can be very massive. In this respect an early appearance of ? resonances is crucial to guarantee the stability of the branch of hadronic stars. Our proposal could be tested by measurements of radii with an error of 1 km, which is within reach of the planned LOFT satellite, and it would be further strengthened by the discovery of compact stars heavier than 2 solar masses.

Reference: A.D., A.Lavagno and G.Pagliara Phys.Rev. D89 (2014) 043014

Presenter: DRAGO, Alessandro (FE)

Session Classification: Part 2

Contribution ID: **15** Type: **not specified**

Kaonic atoms investigation by the SIDDHARTA experiment

Wednesday, 14 May 2014 12:00 (30 minutes)

Presenter: ILIESCU, Mihail Antoniu (LNF)

Session Classification: Part 2

Contribution ID: **16** Type: **not specified**

Y* resonances investigation originated in K-light nuclei absorption by AMADEUS

Wednesday, 14 May 2014 12:30 (30 minutes)

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Presenter: Mr PISCICCHIA, Kristian (LNF)

Session Classification: Part 2

Contribution ID: **17** Type: **not specified**

Single vs multi nucleon absorption processes in low-energy K-nuclei interactions

Wednesday, 14 May 2014 14:30 (30 minutes)

One of the most interesting aspects of low energy QCD in a strangeness sector is to understand how hadron masses and interactions change in the nuclear environment. The antikaon-nucleon potential is investigated searching for signals from possible bound kaonic clusters. The existence of such objects is very debated, and it would open the possibility for the formation of very dense baryonic matter and imply a deep attractive antikaon-nucleon potential.
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Presenter: TUCAKOVIC, Ivana (LNF)

Session Classification: Part 3

Contribution ID: **18** Type: **not specified**

Anisotropic systems of Fermions: gravitational equilibrium and dynamic stability

Wednesday, 14 May 2014 15:00 (30 minutes)

Systems of selfgravitating Fermions constitute a topic of great interest in astrophysics, due to the wide range of applications, and are used also to explain dark matter in galaxies and clusters of galaxies. Here, we study the gravitational equilibrium of spherical models describing a semidegenerate collisionless gas. The Fermi-Dirac distribution function, modified by a cutoff term in order to avoid infinite solutions in mass and radius, is multiplied by an anisotropic term, depending on the angular momentum, evidencing the prevalence of tangential motion of the particles. The starting point is solving the equations of the gravitational equilibrium (both in Newtonian and General Relativistic regime) and analyzing the behavior of the matter density through the calculation of the components of the pressure tensor. We have extended the analysis in the classical regime and in the fully degenerate limit, considering also the problem of the dynamic stability. By solving the equation of the small oscillations for anisotropic systems, new expressions for the critical value of the polytropic exponent are derived, both in Newtonian and General Relativistic regime.

Presenter: ALBERTI, Giuseppe (Univ.Roma1)

Session Classification: Part 3

Contribution ID: **19** Type: **not specified**

Galaxy clusters in presence of dark energy

Wednesday, 14 May 2014 15:30 (30 minutes)

Dark energy, discovered by observations of the SN Ia at redshift z<1, affects the large scale stellar structures in the Universe, like the galaxy clusters. Being the observed velocities of the galaxies inside a cluster largely smaller than the light velocity, we can derive, and numerically solve, the gravitational equilibrium equation in presence of dark energy by considering the Newtonian regime. In the ΛCDM model, dark energy is identified by the Einstein Λ term with a constant energy density. The presence of dark energy in the gravitational equilibrium equation leads to wide regions in the gravity versus dark energy density diagram where the equilibrium solutions are not allowed, due to the prevalence of dark energy effects on the gravity. The improvement of the numerical calculations will allow us to compare the observational data of the galaxy clusters, present in the most important catalogues, with our theoretical model.

Presenter: DONNARI, Martina (Univ. Sapienza)

Session Classification: Part 3

Contribution ID: **20** Type: **not specified**

Gravity and Thermodynamics. I. Fundamental principles

Wednesday, 14 May 2014 16:30 (30 minutes)

Thermodynamics is very important in the dynamical evolution of globular clusters. The effects of the stellar encounters and the evaporation of stars due to the presence of the tidal forces of the galaxy suggest the possibility of considering a thermodynamical equilibrium and therefore a new treatment including the statistical mechanics. It is possible to construct equilibrium models with a different approach by applying thermodynamic principles to a Boltzmann distribution function, with an Hamiltonian which contains an effective potential depending on the kinetic energy of the stars. New relations for the thermodynamical equilibrium in presence of gravity are obtained and the concepts of thermodynamic and kinetic temperature and pressure are introduced. The models present regions with positive and negative specific heat, producing thermodynamic instabilities which drive the clusters towards the so called gravothermal catastrophe, first described by Lynden-Bell and Wood in the well known paper in 1968. The particular distribution of these regions can explain the existence of post-core-collapsed objects, without invoking special processes as the formation of binary systems.

Presenter: FRAGIONE, Giacomo (Univ. Sapienza)

Session Classification: Part 3

Contribution ID: **21** Type: **not specified**

Gravity and thermodynamics: a new point of view in the analysis of equilibrium and dynamical evolution of globular clusters.

Wednesday, 14 May 2014 17:00 (30 minutes)

In the analysis of the evolution of globular clusters, stellar encounters strongly contribute in phase space mixing of stellar orbits. In this scenario, thermodynamics plays a central role in the gravitational equilibrium and stability of the clusters, being binary relaxation time shorter than the age of such systems. On the other hand, the observations of luminosity profiles of globular clusters, at different values of the central gravitational potential, show self similar curves that suggest a unique distribution function (King DF) with changing thermodynamical parameters during the dynamical evolution, according to the numerical simulations existing in literature. This means that the evolution of globular clusters can be studied by considering small thermodynamic transformations which keep constant the functional form of the velocity distribution of stars like in the framework of Boltzmann statistical mechanics. In this way, new relations for the equilibrium are obtained and a different form of the virial theorem which leads to new conclusions in the application of linear series method of Poincaré for gravothermal instability is developed. The results, applied to the new Harris Catalogue for globular clusters, give an important agreement between theory and observations. Finally, for a better understanding of the evolution of globular clusters in our Galaxy and in extragalactic systems, some observative characteristics are presented and analyzed in order to give some explanations on the origin and primeval features of these systems.

Presenter: Prof. MERAFINA, Marco (University of Rome La Sapienza)

Session Classification: Part 3

Contribution ID: **22** Type: **not specified**

Discussions and Conclusions

Wednesday, 14 May 2014 17:30 (30 minutes)