
THESIS ABSTRACTS

This section presents the abstract of most recent Master or PhD thesis related to aerospace technology and management.

A Contribution for the Pre-galactic Universe Study

Eduardo dos Santos Pereira

Instituto Nacional de Pesquisas Espaciais; São José dos Campos/SP – Brazil
pereira.somoza@gmail.com

Thesis submitted for PhD degree in Astrophysics at Instituto Nacional de Pesquisas Espaciais, São José dos Campos, São Paulo, Brazil, in 2012.

ADVISOR: Doctor Oswaldo Duarte Miranda.

KEYWORDS: Cosmology, Structures formation, Gravitational waves, Black holes, Astrophysical computing.

ABSTRACT: We developed a model based on the “Press-Schechter-like formalism”, which allows the derivation of the cosmic star formation rate (CSFR). In particular, our CSFR produces good agreement with observational data for redshifts $z < 6$. Using the CSFR, we studied the stochastic backgrounds of gravitational waves produced by the collapse of stars to produce black holes as remnants. We have obtained, for some models, Signal to Noise ratios $(S/N) > 10$ from the correlation of two advanced LIGO detectors (Advanced LIGO or LIGO III). Another possibility of gravitational wave detector, for the next decade, is the Einstein Telescope (ET), which will increase the Signal to Noise ratios studied in this work by a factor of 10. Thus, gravitational wave astronomy can contribute greatly to the study of pre-galactic universe, helping to reconstruct the history of star formation at high redshifts. We also studied the growth of supermassive black holes and their connection with the CSFR. In particular, from seeds of 1000 solar Mass (at a redshift of ~ 20), we reconstructed the evolution of the comoving density of black holes just using Soltan’s argument. In order to reproduce the quasar luminosity function (QLF), our model shows that the mean radiative efficiency of the accretion disks should be a function of redshift. An interesting result is that the duty-cycle of quasars is maximum within the redshift range 8.5 to 11, which is within the observational uncertainties associated with the reionization of the Universe. Thus, perhaps mini-quasars may have had an important role during the reionization of our universe. This thesis also produced a framework called PyGravWC for the study of cosmology and gravitational waves

of cosmological origin. This framework is available to the community if respected the term of the GNU-GPL.

Tack Study in Prepregs of Epoxy Resin Reinforced with Carbon Fiber

Eduardo Gouveia Martins Romão

Faculdade de Engenharia de Guaratinguetá; Guaratinguetá/SP – Brazil
romao_eduardo@yahoo.com.br

Thesis submitted for Masters in Mechanical Engineering at Faculdade de Engenharia de Guaratinguetá, Guaratinguetá, São Paulo State, Brazil, 2012.

ADVISORS: Drs. Michelle Leali Costa and Edson Cochieri Botelho

KEYWORDS: Tack, Prepreg, Mechanical testing, Thermal analysis, Polymeric composites.

ABSTRACT: Tests to prepreg tack evaluation are very important in the aeronautic field due to the previous knowledge of this property can result in great economy and safety in the manufacturing of aeronautical structural components. However, there is no standardization in literature of a specific test for this type material. It is often necessary to use standards applied to other types of products, which may lead to unreliable results. Besides the methodology for tests, the storage conditions could affect directly the condition of adhesion between layers and, thereby, the quality of manufactured parts made by prepreg. Then, this dissertation aims to develop a methodology for evaluating the tack in prepregs of epoxy matrix reinforced with carbon fibers building a device specially designed for this purpose. Furthermore, with this device and the proposed method, a study of the freezer storage time influence in the prepreg carbon fiber/epoxy resin was also performed. As auxiliary techniques for this study, the curing of the prepreg by differential scanning calorimetry (DSC), the glass transition temperature and elastic modulus by dynamic mechanical analysis (DMA) were evaluated. The device developed shown to be effective to measure the separation energy for the fresh prepreg as storage for one year.

Global Instability Analysis of Compressible Flow

Elmer Mateus Gennaro

Escola de Engenharia de São Carlos; São Carlos/SP – Brazil
elmer@sc.usp.br

Thesis submitted for the degree of PhD in Mechanical Engineering at Universidade de São Paulo, São Carlos, São Paulo State, Brazil, 2012.

ADVISORS: Doctors Marcello A. Faraco de Medeiros and Vassilis Theofilis

KEYWORDS: Hydrodynamic instability, BiGlobal instability analysis, Eigenvalue problem, Arnoldi Method, Compressible flow.

ABSTRACT: The investigation of linear instability mechanisms is essential for understanding the process of transition from laminar to turbulent flow. This thesis has presented an algorithm for the numerical solution of the compressible BiGlobal eigenvalue problem. This algorithm explores the sparsity of the matrices resulting from the spatial discretization of the eigenvalue problem in order to improve the performance in terms of both memory and CPU time over previous dense algebra solutions. Both methods of spectral collocation and finite difference spatial discretization have been implemented and a performance study has been carried out in order to determine the best practice for the efficient solution of a general physical problem with sparse matrix techniques. A combination of spectral collocation and finite differences can further improve the performance. The code developed was then applied in order to revisit and complete the parametric analyses on global instability of the compressible swept Hiemenz flow initiated by Theofilis *et al.* (2004) and neutral curves have been obtained by this flow as a function of the Mach number in the $0 < Ma < 1$ range. The present numerical results fully confirm the asymptotic theory values presented by Theofilis *et al.* (2004). This work presented a complete parametric study of the instability properties of modal three dimensional disturbances in the subsonic range for the flow configuration at hand. Up to the subsonic maximum Mach number value studied, it was found that an increase in this parameter reduces the critical Reynolds number and the range of the unstable spanwise wavenumbers.

The Influence of Erosion and Wear on the Accretion and Adhesion of Ice for Nano Reinforced Polymeric Composites Used in Aeronautics

Omid Gohardani

Cranfield University, Cranfield, United Kingdom;
omid.gohardani.cranfield@gmail.com

Thesis submitted for the degree of Ph.D. in Aerospace Engineering, at Cranfield University, Cranfield, United Kingdom, 2011.

ADVISOR: Dr. David W. Hammond

KEYWORDS: Aircraft icing, Liquid erosion, Rain erosion, Nanotube composites, Polymer matrix composites.

ABSTRACT: The usage of polymeric matrix composites in aerospace applications has been significantly prevalent based on their desired material characteristics, which include higher strength, lower weight and heat resistance. With current advancements in nanotechnology, carbon nanotube reinforced polymeric matrix composites may enhance the operational usage of these advanced materials even further. In this study, a set of novel aerospace material candidates are characterized based on their mechanical properties, resilience to liquid erosion, wettability, and ice adhesion. The experimental evaluations presented allow for a preliminary ranking of the polymeric matrix composites and assessment of the influence of reinforcing carbon nanotubes. The role of erosion in particular is highlighted from both a historical viewpoint and based on empirical results for static and dynamic wettability and ice adhesion. Discussion of different ranking systems and fractography arising as a consequence of liquid impact is further addressed in this study. It is found that the candidate samples exhibit different physical parameters, but nominally similar erosion resilience, despite the presence of the reinforcing carbon nanotubes. The wettability of the experimental materials and their ice adhesion characteristics are further shown to be influenced by the presence of carbon nanotubes and largely dependent upon degradation of the material surfaces.