



DELIBERA

Organo	COMITATO PER IL RECLUTAMENTO E LO SVILUPPO DELLE CARRIERE
Data seduta	18 gennaio 2018 – seduta telematica
Sede	Via Calepina, 14 - Trento
Oggetto	Valutazione di ricercatore di cui all'art. 24, comma 3, lett. b), L. 240/2010 ai fini della chiamata nel ruolo di professore associato: dott. Luis Eduardo Solá Conde, Dipartimento di Matematica.

Sono presenti alla deliberazione:

VALENTINA NIDER	Presidente	P
ALBERTO BELLIN	Componente	P
YURI BOZZI	Componente con funzioni di segretario	P
LUCA NOGLER	Componente	P
RAUL PAOLO SERAPIONI	Componente	P

P = presente; AG = assente giustificato; A = assente

Visto lo Statuto dell'Università degli Studi di Trento emanato con D.R. 167 del 23.04.2012;

Vista la legge 30 dicembre 2010 n. 240 "Norme in materia di organizzazione delle Università, di personale accademico e reclutamento, nonché delega al Governo per incentivare la qualità e l'efficienza del sistema universitario" e in particolare l'art. 24, comma 5;

Visto il Regolamento per il Reclutamento e la progressione di carriera di professori e ricercatori, emanato con D.R. n. 563 del 29 ottobre 2013 e in particolare l'art. 32 "Valutazione dei titolari dei contratti di cui all'art. 20, comma 1, lettera b) del presente Regolamento ai fini della chiamata nel ruolo di professore associato";

Visti i "Criteri per la valutazione dei ricercatori a tempo indeterminato con contratto di cui al comma 3, lettera b), dell'art. 24 della Legge 240/2010, ai fini della chiamata nel ruolo di professore associato", approvati dal Comitato per il Reclutamento e lo Sviluppo delle Carriere nella seduta del 21 luglio 2015;

Vista la delibera del Consiglio del Dipartimento di Matematica del 31 agosto 2017, con la quale si esprime parere favorevole all'inquadramento del dott. **Luis Eduardo Solá Conde** nel ruolo di professore associato per il settore concorsuale 01/A2 (Geometria e Algebra);

Vista la propria delibera del 23 ottobre 2017, con la quale sono stati individuati i referee esterni chiamati a valutare la maturità scientifica e didattica del dott. **Luis Eduardo Solá Conde** nel ruolo di professore associato per il settore concorsuale 01/A2 (Geometria e Algebra);

Viste le valutazioni espresse dai tre referee sul profilo del dott. **Luis Eduardo Solá Conde**, di cui sono riportati di seguito alcuni estratti:

Referee 1:

Il Comitato mi ha chiesto un parere sull'attività scientifica di Luis Solá Conde, in vista della sua promozione a Professore Associato. [...] mi limito a prendere in considerazione l'attività scientifica degli ultimi tre anni.

La ricerca di Solá Conde si è svolta principalmente nella geometria algebrica complessa, più precisamente nel campo delle varietà di Fano e famiglie di curve razionali. La produzione scientifica di Solá Conde continua a essere molto buona, con numerosi articoli pubblicati su riviste internazionali molto buone e talora ottime. Le pubblicazioni di questi anni riguardano principalmente l'ambizioso progetto di ricerca portato avanti in collaborazione con Gianluca Occhetta (Trento), Roberto Muñoz (Madrid), Kiwamu Watanabe (Giappone) e Jaroslaw Wisniewski (Varsavia) sulla congettura di Campana - Peternell. Si tratta di un'importante congettura, famosa e notoriamente difficile, aperta dai primi anni '90, sulle varietà di Fano con fibrato tangente nef. Il gruppo ha pro- posto un'interessante nuova strategia per affrontare questo problema, basata sullo studio delle famiglie di curve razionali sulla varietà, che ha portato ad alcuni risultati nella direzione della congettura; si tratta di lavori interessanti e originali. I preprint arXiv recenti di Solá Conde mostrano il proseguimento della collaborazione sulle varietà di Fano e famiglie di curve razionali, su un progetto che nasce in maniera naturale dai lavori precedenti. Tale progetto riguarda lo studio dei fibrati in varietà omogenee su varietà di Fano, che siano uniformi rispetto ad un'opportuna famiglia di curve razionali. Solá Conde ha anche un filone di ricerca minore su temi di matematica applicata, che mette in luce la sua flessibilità e la capacità di collaborare con colleghi di altri settori. Ha conseguito l'Abilitazione Scientifica Nazionale in Geometria e Algebra nella prima tornata 2016. In conclusione, ritengo che Solá Conde abbia pienamente raggiunto la maturità scientifica per essere Professore Associato.

Referee n. 2:

Luis Solá Conde and his collaborators have produced, over the last years, a remarkably coherent series of works whose main theme is at the heart of the classification problem for complex algebraic varieties. To put



these works in context, let me recall a celebrated theorem of Mori, according to which a complex algebraic manifold whose tangent bundle is ample must be a projective space. More generally, it is a famous conjecture of Campana and Peternell that a Fano manifold whose tangent bundle is nef must be rational homogeneous (that is, a generalized Grassmannian, or a generalized flag manifold). This conjecture (till widely open) is an important piece of the classification program for Fano manifolds.

The now standard approach to the geometry of Fano manifolds, promoted by the spectacular achievements of the so-called Mori theory, is based on the study of their rational curves, in particular those of minimal degree among the families that cover a given variety. In the case of rational homogeneous spaces, those curves are well understood, and a vast program has been launched by Hwang and Mok in order to prove that those manifolds can be characterized by the geometry of their minimal rational curves, incarnated by their so-called VMRT (Varieties of Minimal Rational Tangents). This program has been very successful for generalized Grassmannians associated to long simple roots of the corresponding simple Lie algebras, but the case of short roots is more difficult.

The main ambition of Luis Solá Conde and his collaborators is to attack the Campana-Peternell conjecture by using Mori theory. They have written a very nice survey on the conjecture, the partial results that have already been obtained, the approaches that could be useful. A very nice idea that they have been able to implement is to reconstruct, starting from a Fano manifold with nef tangent bundle, the combinatorial data that should encode the algebraic group acting transitively on the manifold. The problem is then to find a geometric way to compare the variety with the homogeneous spaces of this group. The authors have been able to do so when the manifold has all its Mori contractions given by P^1 -fibrations; then it must be a generalized complete flag manifold. A beautiful result from the same vein is that a Fano manifold of Picard rank two, admitting two P^1 -fibrations, must be the generalized complete flag manifold of a simple group of rank two. Of course the main issue remains to understand rational curves on Fano manifolds with nef tangent bundle. In the paper *Flag bundles on Fano manifolds* (*J. Math. Pures Appl.* 106 (2016)), Luis Solá Conde and his collaborators prove the Campana-Peternell conjecture under the (strong) hypothesis that there exists a dominating complete smooth family of rational curves such that the subfamily of curves passing through a given point is itself a rational homogeneous manifold. This sustains the hope to be able to implement a proof of the general conjecture by induction on the dimension. This also stresses the importance of studying G -principal bundles on the varieties in question.

This study led Luis Solá Conde and their collaborators to prove nice decomposability results for uniform G -principal bundles on rational homogeneous manifolds. A vector bundle on projective space is called uniform if the isomorphism type of its restriction to a projective line is independent of the chosen line; celebrated theorems of the 1980's classify uniform vector bundles of low rank; in particular a uniform bundle whose rank is smaller than the dimension of the ambient projective space must be a sum of line bundles. In a very recent preprint ([arXiv:1711.10908](https://arxiv.org/abs/1711.10908)), Luis Solá Conde and his collaborators have been able to extend this notion of uniformity to principal bundles, make some nice conjectures on uniform principal bundles of low rank, and they managed to prove them in certain important cases.

Let me finally mention that their insights on the geometry of rational curves have allowed Luis Solá Conde and his collaborators to make very interesting progress on the Hwang-Mok programme to characterize rational homogeneous manifolds by their VMRT. Namely, they have been able to tackle some of the most difficult cases, corresponding to short roots, under some technical hypothesis. This is already very nice.

The research themes of Luis Solá Conde combine classical questions (uniform bundles, characterization of homogeneous spaces) with modern techniques (families of rational curves, Mori theory) that are very important and widely used in complex algebraic geometry. With his collaborators he has obtained very nice results on notoriously difficult problems and conjectures. This obviously required a deep understanding of a great variety of techniques. I have therefore no doubt that Luis Solá Conde has reached the scientific maturity needed for being promoted to the position of Associate Professor".

Referee 3:

[...] In the past three years Solá Conde has published nine research articles, including articles in excellent journals such as *Journal de Mathématiques Pures et Appliquées*, and *Mathematische Annalen*. His primary area of research is algebraic geometry, where he has made significant contributions in the past three years as I discuss below. He has also written several articles in applied mathematics on logistical networks, which I am not qualified to address, but they clearly illustrate a breadth of mathematical interests.

Background. A Fano manifold is a complex manifold with first Chern class positive (like projective space, in contrast to most complex algebraic varieties which have negative first Chern class). Fano manifolds have the property that they are \mathbb{P}^1 -uniruled, that is, for any $x \in X$, there exists a rational curve (i.e., a variety isomorphic to \mathbb{P}^1) on X containing x . Fano manifolds have been the object of intense study and there are numerous important conjectures regarding them.

A line bundle L on a projective manifold X is said to be numerically effective or nef if $L \cdot C \geq 0$ for all compact curves $C \subset X$. A vector bundle E is nef if the line bundle $\mathcal{O}_E(1)$ on the projective bundle of hyperplanes in the fibers of E is nef.

A variety of the form G/P where G is a semi-simple algebraic group and P is a parabolic subgroup is called rational homogeneous. Examples include projective space, Grassmannians and more general flag varieties.



Rational homogeneous varieties are Fano.

A famous and notoriously difficult conjecture by Campana and Peternell asserts that a Fano manifold with numerically effective tangent bundle must be rational homogeneous. Call such a Fano manifold a CP-manifold. I will focus on Solá Conde's contributions towards this important conjecture.

A program to solve the Campana-Peternell conjecture. First, in Rational curves, Dynkin diagrams and Fano manifolds with nef tangent bundle with Muñoz, Occhetta and Watanabe, (Math. Ann. 361 (2015), no. 3-4, 583609), they outline a program for proving the conjecture. This already is significant, as all previous positive results regarding the conjecture were indirect, in the sense that they relied on complete classifications of certain types of Fano manifolds and only afterwards showed that the relevant ones are homogeneous. Mori theory tells us that given a smooth (complex) projective variety X , we can contract a negative extremal ray (if there are any) and obtain a regular map $c : X \dashrightarrow Y$. The details are not important for us here, but the essential point is that in this paper they prove that all Mori contractions of CP-manifolds are smooth vibrations, whose fibers and target are again CP-manifolds, which enables one to break down the question to smaller questions, lending hope of an induction argument. A second important result of the paper is that they give a procedure to associate a Dynkin diagram of a semi-simple group naturally to a CP-manifold. The goal then becomes to show that the CP-manifold must in fact be a homogeneous variety of that group. They prove this is indeed the case when X is "flag type" and the associated Dynkin diagram is of type A_n .

In Fano manifolds whose elementary contractions are smooth \mathbb{P}^1 -fibrations: a geometrie characterization of flag varieties, with Occhetta, Watanabe, and Wisniewski, (Ann. Se. Norm. Super. Pisa Cl. Sci. (5) 17 (2017), no. 2, 573607), they showed that flag manifolds are characterized within the class of Fano manifolds by having only \mathbb{P}^1 -bundles as elementary contractions. In particular, one may then try to use this result to prove the homogeneity of a certain Fano manifold X by "untangling" its families of extremal rational curves, constructing another Fano manifold Z and a dominating map $Z \dashrightarrow X$ satisfying the above property.

In Flag bundles on Fano manifolds, with Occhetta and Wisniewski (J. Math. Pures Appl. (9) 106 (2016), no. 4, 651669), they show that under many circumstances, if the fibers of the map c above are rational homogeneous, then the variety Y must be rational homogeneous, results of interest in their own right as well as significant evidence of the viability of their program.

Other work in algebraic geometry. I briefly mention two other papers. In A characterization of symplectic Grassmannians, with Occhetta and Watanabe (Math. Z. 286 (2017), no. 3-4, 14211433), they advance the Hwang-Mok program of characterizing rational homogeneous varieties X in terms of the variety of tangent directions to minimal rational curves through a general $x \in X$. The paper On the existence of a weak Zariski decomposition on projectivized vector bundles, with Muñoz and Di Sciuolo (Geom. Dedicata 179 (2015), 287301), proves the existence of a weak Zariski decomposition of a divisor in two situations. The Zariski decomposition of an effective divisor (line bundle) on a surface writes it as a sum $D = P + N$ of a nef divisor P and a positive divisor N whose irreducible components are orthogonal to P . They prove the existence of a weakened, but still useful generalization when X is the total space of a projective bundle over a curve or a Fano variety satisfying additional conditions.

Conclusion. I was asked to determine if Solá Conde has reached the scientific maturity needed for being promoted to the position of Associate Professor at the University of Trento. Based on the results discussed above, the answer is clearly yes. [...] Any university would be very fortunate to have such an excellent and productive researcher.

Visto il *curriculum vitae* del dott. **Luis Eduardo Solá Conde**;

Con voto unanime;

Delibera

1. di formulare la seguente valutazione del dott. **Luis Eduardo Solá Conde**, ai fini della chiamata ai sensi dell'art. 24 comma 5, L. 240/2010 nel ruolo di professore associato per il settore concorsuale 01/A2 (Geometria e Algebra):

*I giudizi espressi dai referee esterni sul contributo scientifico, la qualità dell'attività di ricerca e l'esperienza professionale del dott. **Luis Eduardo Solá Conde**, nonché sulla coerenza del suo profilo con i requisiti attesi per il ruolo di professore di seconda fascia, sono molto positivi.*

*A seguito di attenta valutazione del curriculum e delle pubblicazioni, e sulla base dei giudizi formulati dai referee, il Comitato ritiene il profilo scientifico del candidato adeguato al ruolo ed esprime parere favorevole alla chiamata del dott. **Luis Eduardo Solá Conde** nel ruolo di professore associato per il settore concorsuale 01/A2 (Geometria e Algebra).*

F.to Il Presidente
Prof.ssa Valentina Nider

F.to Il Segretario
Prof. Yuri Bozzi