PROGRAMA FONDECYT
INFORME FINAL
ETAPA 2016

COMISIÓN NACIONAL DE INVESTIGACION CIENTÍFICA Y TECNOLÓGICA
VERSION OFICIAL N° 2
FECHA: 09/01/2018

N° PROYECTO: 11140572  DURACIÓN: 3 años  AÑO ETAPA: 2016
TÍTULO PROYECTO: OBSERVATIONAL CONSTRAINS TO THE MECHANISM OF FORMATION AND EARLY EVOLUTION OF VERY LOW-MASS STARS AND BROWN DWARFS

DISCIPLINA PRINCIPAL: ASTRONOMIA
GRUPO DE ESTUDIO: ASTRON., COSMOL. Y PAR
INVESTIGADOR(A) RESPONSABLE: AMELIA MARIA BAYO ARAN
DIRECCIÓN:
COMUNA: VALPARAISO
CIUDAD: Valparaiso
REGIÓN: V REGION

FONDO NACIONAL DE DESARROLLO CIENTIFICO Y TECNOLOGICO (FONDECYT)
Moneda 1375, Santiago de Chile - casilla 297-V, Santiago 21
Teléfono: 2435 4350 FAX 2365 4435
Email: informes.fondecyt@conicyt.cl
Objetivos

Cumplimiento de los Objetivos planteados en la etapa final, o pendientes de cumplir. Recuerde que en esta sección debe referirse a objetivos desarrollados, NO listar actividades desarrolladas.

<table>
<thead>
<tr>
<th>N°</th>
<th>OBJETIVOS</th>
<th>CUMPLIMIENTO</th>
<th>FUNDAMENTO</th>
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<tbody>
<tr>
<td>1</td>
<td>Progress in the understanding of the formation mechanism of substellar objects by finding them at their earliest stages of evolution.</td>
<td>TOTAL</td>
<td>Recently in Barrado et al. (2017, accepted to A&amp;A). We have shown our progress in the look for pre and proto-brown dwarfs in Barnard 30 (a dark cloud associated to the Lambda Orionis Star Forming region). We have obtained a number of candidates to pre and proto brown dwarfs and stars. In this and previous works I have been in charge of the multi-wavelength SED assembling process combining very different angular resolution data to have a better assessment of the evolutionary status of the submm sources. As a result of the relatively high contamination rate that we have found (less than one fourth of the proto-brown dwarf candidates obtained from single dish observations turned out to be actual extremely young sources and not just inhomogeneities of the cloud) with the study of Barnard 30, I am leading a new approach combining APEX programs with ALMA ACA (low resolution) to add to the candidate selection criteria intermediate resolution data and a spectral index.</td>
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<td></td>
<td>Progress in the understanding of the formation mechanism of brown dwarfs by comparisons of coeval low-mass stars and brown dwarfs populations.</td>
<td>TOTAL</td>
<td>In Bayo et al. (2017) we have detected for the first time in the mm range, the disk around an isolated planetary mass object. The mass of the disk estimated for this object from our ALMA data allows us to infer that, with the few objects observed so far (again, this is, by far, the lowest central mass object studied in this way), all brown dwarf disk masses seem to scale in a consistent regime with the mass of the central object, pointing in principle to turbulent fragmentation as the dominant mechanism for brown dwarf formation. However, the object count is very low, and most disks are not resolved. Resolving these disks and comparing their extent with those around higher mass objects is something I have started putting proposals on for the future, and will allow to have a more direct constraint to, for example, rule out ejection based scenarios.</td>
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<td>Progress in the understanding of the formation mechanism of brown dwarfs by comparisons of spectroscopic derived properties of coeval low-mass stars in large numbers.</td>
<td>PARCIAL</td>
<td>Unfortunately, the Gaia ESO internal data release of Barnard 30 and Barnard 35, only happened in October 2017, almost two years delay with respect to the initially planed strategy from the consortia, and not even covering completely the two dark clouds. Since the release date I have been working on the analysis, and although tentatively we see interesting trends like an evolution at the critical mass of the central object for a change in the disk fraction, I am not in finished with the analysis yet, and the results will only be ready by mid 2018.</td>
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Otro(s) aspecto(s) que Ud. considere importante(s) en la evaluación del cumplimiento de objetivos planteados en la propuesta original o en las modificaciones autorizadas por los Consejos.

I want to highlight, as in the report from the previous year, that, facing the continuous delays in the obtention and delivery of the Gaia ESO data for Barnard 30 and Barnard 35, I have moved my focus to different datasets, in this case, particularly ALMA (and APEX) data, to address the same science questions from a different perspective, in fact, in a more innovative way than previously foreseen in my Iniciación Project. I hope this is not a problem since, the "lack of originality" was the only criticism I had from the referees that supported my application.
RESULTS OBTAINED:
For each specific goal, describe or summarize the results obtained. Relate each one to work already published and/or manuscripts submitted. In the Annex section include additional information deemed pertinent and relevant to the evaluation process.
The maximum length for this section is 5 pages. (Arial or Verdana, font size 10).

1.- Progress in the understanding of the formation mechanism of substellar objects by finding them at their earliest stages of evolution.
In de Gregorio-Monsalvo et al (2016), Huélamo et al. (2017), and Barrado et al. (2018, accepted for publication in A&A). We have shown our progress in the look for pre and proto-brown dwarfs in Chamaleon II and Barnard 30 (a dark cloud associated to the Lambda Orionis Star Forming region). We have obtained a number of candidates to pre and proto brown dwarfs and stars. In these works I have been in charge of the multi-wavelength SED assembling process combining very different angular resolution data to have a better assessment of the evolutionary status of the submm sources.
As a result of the relatively high contamination rate that we have found (less than one fourth of the proto-brown dwarf candidates obtained from single dish observations turned out to be actual extremely young sources and not just inhomogeneities of the cloud) with the study of Barnard 30, I am leading a new approach combining APEX programs with ALMA ACA (low resolution) to add to the candidate selection criteria two very important aspects: intermediate resolution data and a spectral index (observing in two bands since the beginning. The ACA and APEX data have already been observed, and the analysis if these data is one of the main goals for a new project.

2.- Progress in the understanding of the formation mechanism of brown dwarfs by comparisons of coeval low-mass stars and brown dwarfs populations.
OTS44 is one of only four free-floating planets known to have a disk. We have previously shown that it is the coolest and least massive known free-floating planet (~12 M_Jup) with a substantial disk that is actively accreting.
In Bayo et al 2017, we presented our Band 6 (233 GHz) ALMA continuum data of this very young disk-bearing object. The data shows a clear unresolved detection of the source. We obtained disk-mass estimates via empirical correlations derived for young, higher-mass, central (substellar) objects. The range of values obtained are between 0.07 and 0.63 M_⊙ (dust masses). We compared the properties of this unique disk with those recently reported around higher-mass (brown dwarfs) young...
objects in order to infer constraints on its mechanism of formation. While extreme assumptions on dust temperature yield disk-mass values that could slightly diverge from the general trends found for more massive brown dwarfs, a range of sensible values provide disk masses compatible with a unique scaling relation between $M_{\text{dust}}$ and $M_*$ through the substellar domain down to planetary masses.

3.-Progress in the understanding of the formation mechanism of brown dwarfs by comparisons of spectroscopic derived properties of coeval low-mass stars in large numbers. Unfortunately, the Gaia ESO internal data release of Barnard 30 and Barnard 35, only happened in October 2017, almost two years delay with respect to the initially planed strategy from the consortia. In addition, this data release, does not even cover completely the two dark clouds. Since the release date I have been working on the analysis, and although tentatively we see interesting trends like an evolution at the critical mass of the central object for a change in the disk fraction, I am not in finished with the analysis yet, and the results will only be ready by mid 2018.
ACHIEVEMENTS OF THE PROJECT:
- Research visit(s) to other institution(s).
- Outreach activities related to the projects main topic.
- Any other contribution, not addressed elsewhere, that you consider important.

The maximum length for this section is 1 page. (Arial or Verdana, font size 10).

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1. Research visits: During this year I have contributed to weekly meetings in Santiago as part of the working group to justify the need for the creation of a Chilean Data Center. In addition, I participated with contributed talks to the International meeting “Cosmic Dust” in Tokyo, Japan and the Star Formation, ESO/ALMA workshop in Santiago, Chile; presenting respectively, modeling and empirical estimates of the mass of the disk around the planetary mass object OTS44. I also presented the results on OTS 44 in a poster in the International meeting of Star Formation in homage of F. Palla in Florence, Italy. Finally, I conducted a short research stay in Madrid in order to evaluate the change of strategy in searching for proto-substellar objects, and participated with two talks in the SOCHIAS annual meeting.

2. Outreach: In the extended report the itemized list here is expanded – Three talks within the 1000 Científicos 1000 Aulas program
   – Día de la astronomía in Valparaiso full organization.
   – Host of the “Educación Futuro” program.
   – Jurado “Congreso Regional Escolar” Explora Valparaíso
   – “Fiesta de la Ciencia”, Explora Valparaíso
   – Invited talk in the American Academy for Science in Santiago

3. Advising graduate and postgraduate students:
   – D. Iglesias: PhD student, gas in debris disks, first first author paper to be submitted Jan 2018 (manuscript available upon request
   – A. Aguayo: MsC student, accretion on substellar objects. Analysis in progress.

4. Other activities:
   – Co-Chair, mentor and faculty of La Serena School for Data Science 2017
   – Various observing campaigns
COOPERACIÓN INTERNACIONAL

Nº Proyecto: 11140572
Nombre Colaborador (a) Extranjero (a): DAVID BARRADO NAVASCUES
Afiliación Institucional Actual: CENTRO DE ASTROBIOLOGIA
Fechas de estadía Desde: 14/10/2017 Hasta: 21/10/2017

Describa las actividades realizadas y resultados obtenidos. Destaque su contribución al logro de los objetivos del proyecto. Si es pertinente, indique las publicaciones conjuntas generadas, haciendo referencia a lo informado en la etapa Productos. Agregue en la etapa anexos la información necesaria.

- Finishing the last corrections of the work on the LABOCA (and SABOCA) observations of Barnard 30 searching for proto-substellar object candidates.
- The resulting corrections translated in the paper being accepted in November (see products, Barrado et al. 2018, accepted)

PRODUCTOS

ARTÍCULOS
Para trabajos en Prensa/ Aceptados/Enviados adjunte copia de carta de aceptación o de recepción.

Nº: 1
Autor (a)(es/as): Bayo, A.; Joergens, V.; et al. (last author Chauvin, G.)
Título (Idioma original): First Millimeter Detection of the Disk around a Young, Isolated, Planetary-mass Object
Indexación: WoS
ISSN: 1538-4357
Año: 2017
Vol.: 841
Nº: 1
Páginas: 4pp
Estado de la publicación a la fecha: Publicada
Otras Fuentes de financiamiento, si las hay:

Early phases in the stellar and substellar formation and evolution: Infrared and submillimeter data in the Barnard 30 dark cloud

Astronomy & Astrophysics

WoS

1432-0746

ORS PUBLICACIONES / PRODUCTOS

Sin información ingresada.

CONGRESOS

Amelia Bayo , Viki Joergens, et al. last author Gael Chauvin

Modeling the first millimeter detection of the disk around a young, isolated, planetary-mass object

Cosmic Dust

JAPON

Mitaka
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<th>País</th>
<th>Ciudad</th>
<th>Fecha Inicio</th>
<th>Fecha Término</th>
<th>Nombre Publicación</th>
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<td>2</td>
<td>A. Bayo, V. Joergens, et al. last author: G. Chauvin</td>
<td>First sub-mm detection of a disk-bearing young isolated planetary mass object</td>
<td>Star Formation from Cores to Clusters</td>
<td>CHILE</td>
<td>Santiago</td>
<td>06/03/2017</td>
<td>09/03/2017</td>
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<td>3</td>
<td>Bayo, A.; Joergens, V.; et al. (last author Chauvin, G.)</td>
<td>First submillimeter detection of the disk around a young, isolated, planetary-mass object</td>
<td>Francesco's Legacy Star Formation in Space and Time</td>
<td>ITALIA</td>
<td>Florencia</td>
<td>05/06/2017</td>
<td>09/06/2017</td>
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TESIS/MEMORIAS

Nº : 1
Título de Tesis : Entendiendo la atmósfera de TWA 7
Nombre y Apellidos del(de la) Alumno(a) : Catalina Zamora Martínez
Nombre y Apellidos del(de la) Tutor(a) : Amelia Bayo
Título Grado : Pregrado
Institución : Universidad de Valparaiso
País : CHILE
Ciudad : Valparaíso
Estado de Tesis : Terminada
Fecha Inicio : 21/08/2017
Fecha Término : 20/12/2017
Envía documento en papel : no
Archivo Asociado :
certificado_nota_9e239c670df21be21ed9e5defa7a90.pdf
manuscrito_seminariodegrado_CZAMORA.pdf

Nº : 2
Título de Tesis : Accretion on substellar objects
Nombre y Apellidos del(de la) Alumno(a) : Aurora Aguayo Villegas
Nombre y Apellidos del(de la) Tutor(a) : Amelia Bayo
Título Grado : Magister
Institución : Universidad de Valparaiso
País : CHILE
Ciudad : Valparaíso
Estado de Tesis : En Ejecución
Fecha Inicio : 14/06/2017
Fecha Término : 30/01/2018
Envía documento en papel : no
Archivo Asociado :
Daniela_Aurora_Javier.pdf
ANEXOS

<table>
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<tr>
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</table>

A continuación se detallan los anexos físicos/papel que no se incluyen en el informe en formato PDF.