The Galactic Center

N

S–Stars and Sagittarius A*.

Mini–Spiral: Northern Arm

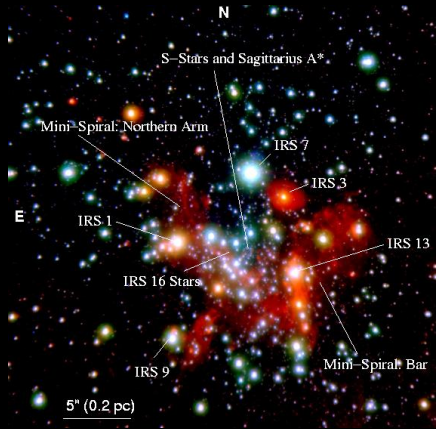IRS 7

IRS 3

E

IRS 1

IRS 13

IRS 16 Stars

IRS 9

Mini–Spiral Bar

5" (0.2 pc)

The Center of our Milky Way is the only nucleus of a Galaxy which we can study in detail as we can resolve there individually the stellar populations. Together with the existence of the supermassive black hole of Sgr*, this part of our Galaxy is one of the most extreme environment where star formation can happen. Crowding and heavy interstellar reddening obliges to work in the infrared. This module proposes to study different stellar populations in these extreme regions dominated by the supermassive blackhole such as young stellar objects, intermediate age AGB-stars and old red giant branch stars. Using the young stellar objects as tracer of star formation the applicant will determine star formation rates.

OBJECTIVES

- Understanding and analysing photometric data of the nucleus of our Galaxy to study the specific populations in an extreme environment.

- Obtaining a critical view of different data sets at different spatial resolution and sensitivities.

- Develop and apply tools for cross-matching techniques in crowded regions to study stellar populations such as young stellar objets, intermediate-age and old age populations using multiwavelength-data

PREREQUISITES

Stellar Physics (in particular: stellar evolution) and General Astrophysics (Milky Way structure, the Center of the Milky Way, stellar populations). A detailed course about the Center of the Milky Way will be provided as well as the study of specific populations in the Galactic Center such as young stellar objects, AGB stars and red giant branch stars.

THEORY

by Mathias Schultheis

I) Introduction to the central parts of the Milk Way
The nucleus of the Milky Way is the most extreme environment in our Galaxy. It is hosting a massive star cluster of 30 million solar masses coexisting with a supermassive black hole of 4 million solar masses. This central star cluster is a typical representative of a very common class of objects called nuclear star clusters (NSCs), the densest stellar systems in the universe we know of. Given their position at the center of the potential well of a galaxy and their co-existence with black holes, nuclear star clusters potentially play a key role in the formation and certainly in the growth of the central supermassive black hole in a galaxy. The Milky Way nuclear cluster is a unique laboratory to study the co-existence of nuclear stars clusters and supermassive black holes.

II) Star fomation in the Galactic Center region
The Galactic nucleus is an exceptional region for testing massive star formation and evolution models. It contains 10% of the present star formation activity in the Galaxy, yet fills only a tiny fraction of a percent of the volume in the Galactic disk. The initial conditions for star formation in the GC are unique in the Galaxy. The molecular clouds in the region are extraordinary dense, under high thermal pressure, and are subject to a strong gravitational tidal field. In this section we will determine the star formation rate in the inner region using the population of massive young stellar objects.

APPLICATIONS

by M. Schultheis & G. Kordopatis

The student will work on multi-wavelength data -from near-IR spectra which has been recently obtained by the VLT (ESO/Chili), as well as complementary photometric data from the near to the the mid-IR. After getting familiar with the different data sets, the student will cross-match the different data sets in these highly dense regions. They will learn the difficult task in obtaining full spectral energy distributions and confront them with the most recent models of massive YSOs. The final aim is to calculate the present star formation rate and to trace it in the nuclear star cluster as well as in its surrounding environment (nuclear disk, inner bulge). This work is done within our international Galactic Center framework with partners from Heidelberg, Lund, Trieste, Bonn, and Los Angeles where the student will access to the newest observations obtained by large ground-based telescopes.

Galactic Center Survey   HST NICMOS • SST IRAC

NASA, ESA, Q.D. Wang (University of Massachusets, Amherst), and S. Stolovy (Caltech)   STScI-PRC09-02a

HST survey of the Galactic Center with a signs of large star formation activity.

MAIN PROGRESSION STEPS

For instance :

- First quarter of the period: Courses about the galactic Center, the Central Molecular zone and review about stellar populations

- Second quarter: Learning techniques of cross-matching, multi-wavelengh analysis in crowded regions

- Third and fourth quarter: Analysis of specific stellar populations and deriving star formation rates

- Last week: Preparation of the final oral presentation

EVALUATION

- Type of examinations: written, oral presentation, project

- Several exercises will be evaluated to obtain the midterm grade

- Final exam will consist of a summary of the project

- Final exam and mid-term exam will be weighted equally

BIBLIOGRAPHY & RESSOURCES

An overview of the Galactic Center
The nuclear star cluster
Star formation in the Galactic Center
Review about nuclear star cluster

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