**Background on subject. What target(s). How you picked the target(s) and why. What is known in the literature about the target(s). Educated guesses on what you expect to find.**

**Background Information**

Star formation occurs in regions of dense gas and dust called cold dark nebulae. The temperatures of these nebulae are approximately 10K to 100K [Maoz]. The low kinetic energy of the gas and dust particles allows them to form clumps which gradually increase in size. This mass increase causes an increase in gravitational attraction of the particles in the cloud, which in turn causes more mass to fall on the clump, eventually forming a protostar. This process could be occurring in multiple regions in the dust cloud, at various stages and rates, producing from one to hundreds of thousands of protostars, depending on the size and mass of the dust cloud.

Bright rimmed clouds (BRCs) are a type of cold dark nebula and consist of a denser head that appears as a bright rim and less dense tail region [SFO 1991]. They are associated with HII regions that are approximately 106 yrs old [SFO 1991]. BRCs may have been dense regions in a larger molecular cloud that were pushed outward by UV radiation emitted from O or B type stars [SFO 1991]. While BRCs are considered densely packed with dust in the astronomical sense, Maoz presents a comparison that these clouds, “are many orders of magnitude lower than the density of the best vacua achievable in the laboratory” (Maoz pg. 114). The gas and dust are excited by the UV radiation emitted from O or B type stars associated with the dust cloud [SFO 1991]. Star formation is most likely triggered by the UV radiation and strong stellar winds from the associated O and B type stars which compress and ionize the material [Rebull, et al 2011].

BRCs also provide a glimpse of star formation at different stages, depending on the location of the YSOs. Young stars that are very bright IR emitters are typically located near the head of the cloud, and bluer, older stars are located closer to the O or B type star at the tail [Beltrán, et al 2009]. This suggests an evolutionary transition in the cloud known as small-scale sequential star formation [Beltrán, et al 2009].

Bright-rimmed clouds are classified based on the shape of the following three categories; Type A has a moderately curved head, Type B has a head that is very curved, and Type C has a “cometary rim” [SFO 1991]. The curvature is defined as the ratio between the cloud length, *l*, and the width, *w* [SFO 1991]. There is no difference reported in the amount of star formation based on shape.

**Targets**

 The purposes of this study are to identify new young stellar objects (YSOs) in BRC 27, BRC 34, and BRC 38 and to compare these results to previously identified young stellar objects in these regions. This research is an extension of the work done on BRC 27 and 34 by the 2011 NITARP class. This research will focus primarily on the perimeter regions of BRC 27 and 34, which were not studied by the 2011 NITARP class. In addition to BRC 27 and 34, BRC 38 will be studied in its entirety. Archival data from the Spitzer Space Telescope and WISE will be reduced and analyzed to identify YSOs based on the IR excess due to the amount of ambient dust depicted on the YSO candidate’s spectral energy distributions (SEDs). Galaxies and AGB stars are virtually indistinguishable from YSOs in IR data [Rebull, et. al Sept. 2011]. Therefore, optical data from Akari, Haleakala, and 2MASS will be reduced and analyzed to eliminate these contaminants. Additional spectral line data characteristic of YSO formation such as HII may be used as well.

**Target Selection**

The proposed targets were selected based on the availability of Spitzer and WISE archival data, with the possibility of obtaining optical data and spectroscopy data. These regions were selected as they have not been exhaustively studied. Selected perimeter regions of BRC 27 and 34 were chosen based on the availability of Spitzer and WISE data.

**What is Known About Targets**

Ogura, Sugitani, and Pickles (2002) report the number of Hα emission stars in BRCs. BRC 27 contains 32 Hα emission stars, while BRC 34 has two, and BRC 38 has 16. They also reported nine Herbig-Haro objects in BRC 38 [OSP 2002]. The 2011 NITARP group reported that 6 Class I, 13 Class II, 4 Flat, and 14 Class III YSOs were previously identified in BRC 27 and only 1 Class II star in BRC 34 [Johnson, et al Poster 2011]. Their search revealed an additional 11 Class I, 1 Class II, 5 Flat, and 2 Class III stars in BRC 27 and 1 Class I, 1 Class II, and 6 Flat stars in BRC 34 [Johnson, et al Poster 2011].

Question: Johnson, et al Poster does not list the Hα emission stars. Should I include them, or are we not concerned about these?

BRC 38, also referred to as IC 1396, has a molecular cloud mass of 4000M🖸, atomic gas mass of 5000M🖸, and an HII region mass of 3000M🖸 [Weikard et al]. BRC 38 is illuminated by an O6.5-type star, HD 206267 [Weikard, et. al]. Herbig-Haro objects, CO molecular outflows, and H2 jets have all been previously identified in BRC 38 [Beltrán, et al 2009]. Beltrán, et al report 736 sources detected in the JHK’ band [Beltrán, et al 2009].

**What We Expect to Find**

 When examining twenty-six potential star forming regions (twenty two of which were bright-rimmed clouds), an average of sixteen YSO candidates were found in the Ogura, Sugitani, and Pickles (OSP) 2002 study. OSP state that this is an underestimate of actual YSOs in these clouds. Clearly, additional data and analysis are required to get an accurate count of YSO candidates. BRC 27, 34, and 38 are known star-forming regions. This analysis will provide additional confirmation of previously identified YSO candidates, as well as uncover new YSO candidates. YSO candidates emit excess infrared radiation, indicative of a protostar surrounded by dense, gas and dust. YSO candidates will be determined based on their spectral energy distribution (SED) which will clearly show this excess infrared radiation.

 Once new YSOs are identified, they will be classified as Class I, II, Flat or III based on the shape of their SED. The classes are defined by how much radiation is being emitted by the ambient gas and dust. The ambient gas and dust emits in the infrared which obscures the little visible light that is being emitted by the protostar. As the amount of ambient gas and dust decreases either from the protostar accreting material from the dust cloud or from the new stellar wind ejecting the gas and dust, there is less infrared radiation emitted.

 Question: In the research, Classes were 0-III, in the Johnson et al Poster, the classes were 0, I, II, III—why the shift in description?

References in No Particular Order:

Rebull, L.M., *et al*. “New Young Star Candidates in the Taurus-Auriga Region as Selected from the *Wide-field Ingrared Survey Explorer.”* 2011. ApJ. 196,4.

Sugitani, K., Fukui, Y., Ogura, K. “A Catalog of Bright-Rimmed Clouds with *IRAS* Point Sources: Candidates for Star Formation by Radiation-Driven Implosion. I. The Northern Hemisphere. 1991. ApJ. 77:59-66.

Maoz, D., *Astrophysics in a Nutshell.* Princeton University Press. Princeton, NJ. 2007.

Ogura, K., Sugitani, K., and Pickles, A. “Hα Emission Stars and Herbig-Haro Objects in the Vicinity of Bright-Rimmed Clouds.” 2002. AJ.

Beltrán, et al. “The Stellar Population and Complex Structure of the Bright-Rimmed Cloud, IC 1396N.” 2009. A&A.

Johnson, et al. “Spitzer Selected Young Stellar Objects in Bright Rimmed Clouds.” AAS Poster Presentation. 2012.