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A SIMULTANEOUS SOLUTION SCHEME FOR COUPLED TRANSONIC ACCRETION-WIND SYSTEMS

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We discuss a *non-self-similar analytical model* capable of explaining the formation of accretion-powered galactic and extra-galactic jets.

1 Introduction

Though widely observed to be emanating from a variety of astrophysical sources, the underlying physical mechanism behind the formation of galactic and extra-galactic jets is still enshrouded in a veil of mystery. In addition, it has not been possible to calculate accurately the amount of barionic matter expelled in these events. Though progress in modelling the exact mechanism of jet formation has been severely handicapped by inadequacy in understanding the proper micro-physics responsible jet formation, the basic ingradients of a theoretical model in attempt to explain the origin and formation of galactic/extragalactic jets seems to be well agreed upon [1,2,3]. These are: firstly, a deep central potential well provided by an SMBH in case of jets from AGNs and QSOs and stellar mass BHs in case of jets from galactic Microquasars, and secondly, matter accreting onto these central compact objects to provide the energy for continuous throttling of the jets. Because of the fact that BHs don't have their own physical atmosphere from where matter could be ripped off as winds, outflows/jets in these cases *have to be generated only from the accreting material.* This invariable association of accretion processes with jet formation reinforce the belief that for galactic and extra-galactic jet sources, inflow and outflow must be studied within the same framework. Also to be noted that while self-similar models are a valuable first step, they can never be the full answer, and indeed any model which works equally well at all radii is fairly unsatisfactory to prove its viability. Thus the preferred model for jet formation must be one which is able to select the *specific* region of jet formation.

2 Model Description

Keeping the above mentioned facts at the back of our mind, we introduce a *non self-similar analytical model* which provides a simultaneous solution scheme for coupled inflow-outflow systems to explain the hydrodynamic origin of accretion-powered astrophysical outflows [4,5,6,7,8]. By self-consistently combining the exact transonic accretion and wind topologies, we compute the mass outflow rate $R_{\dot{M}}$ (the measure of the fraction of barionic accreting material being expelled as outflows) *only* in terms of accretion parameters scaled in geometrical unit and study the dependence of this rate on various physical quantities governing the flow. We perform our calculation for disk-outflow system as well as for accretion with negligible intrinsic angular momentum. Unlike the self-similar solutions present in the literature, our non-self similar model *for the first time* points out the *exact* location from where outflows are launched.

For the disc-outflow system, after explaining the fundamentals of the physical process by which the outflow may generate from CENtrifugal Pressure Supported BOundary Layers (CENBOL) around accreting compact objects, details of a mathematical scheme capable of simultaneously solving the equations governing accretion and wind is provided [4,7,8]. Connection between inflow-outflow topologies has been established along with the self-consistent computation of the mass outflow rate $R_{\dot{M}}$. Also the dependence of this rate on all possible accretion and shock parameters has been thoroughly investigated.

Generation of outflows from spherical/ quasi-spherical accretion onto non-rotating black holes has also been investigated [5,6,7]. Proposing that a relativistic hadronic interaction supported steady and standing spherical shock may be treated as the virtual hard surface from where the outflow could be launched, mass outflow rate is computed from first principle and its dependence on various flow parameters have been studied by simultaneously solving the inflow-outflow equatoins.

3 Some Important Results and Scopes For Future Work

For high compression ratio near the CENBOL as well as for outflows having large polytropic index, we show that runaway instability can take place by rapid evacuation of accretion disc around the central accretor which indicates that our model is useful in explaining the quiescent states in X-ray novae systems. Also we show that a possible explanation of extremely low luminosity and low radiative efficiency of our galactic centre could be due to the presence of profuse mass loss from near vicinity of Sgr A^* according to our model.

Recently it has been shown that significant neucleosynthesis can take place in accretion discs around black holes[9]. We suggest that outflow generated according to our disc-outflow model would carry away neucleosynthesis generated modified compositions and could contaminate the atmosphere of the surrounding stars and galaxies in general.

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