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astroLLM: An AI-Powered Multi-Agent Research Assistant for Multiwavelength and Multimessenger Astrophysics

The rapid increase in astrophysical data and scientific literature poses a significant challenge for researchers seeking to efficiently process, analyze, and extract meaningful insights. While traditional Large Language Models (LLMs) primarily focus on text-based tasks, there is a pressing need for advanced AI-driven frameworks that seamlessly integrate literature review, data retrieval, and theoretical modeling. To address this, we introduce astroLLM, an AI-powered multi-agent research assistant, in which specialized agents handle literature retrieval, data analysis, and theoretical modeling, collectively providing domain-specific knowledge while enabling access to extensive datasets and novel modeling tools. astroLLM leverages Retrieval-Augmented Generation (RAG) to synthesize information from extensive scientific literature and employs chain-of-thought reasoning to enhance its analytical capabilities and domain-specific applications. It interacts with external computational tools and astrophysical databases, including the Markarian Multiwavelength Data Center (MMDC), providing seamless retrieval of multiwavelength and multimessenger data from diverse catalogs. The framework also facilitates theoretical modeling through Convolutional Neural Networks (CNNs), which are trained on outputs from leptonic and lepto-hadronic models, thus enabling accurate spectral energy distribution (SED) modeling, parameter estimation, and computational optimization. As a first step, astroLLM v1.0 is tailored for blazar research, with future expansions planned to progressively include other astrophysical source classes. This presentation will discuss the architecture of astroLLM, its integration with external astrophysical resources, and its key applications in high-energy astrophysics. We will also highlight the advantages of AI-driven frameworks in multiwavelength and multimessenger studies and explore the broader impact of LLM-assisted research in astrophysics.

AI keywords

Foundation Models; Multi-Agent Systems; Retrieval-Augmented Generation; Explainable AI

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Track Classification: Foundation Models