Detailed Photoionization Analysis of Chemodynamical Simulation Results for the Evolution of Dwarf Star-Forming Galaxies at an Age of 100 Myr

Thursday, 12 June 2025 12:20 (20 minutes)

```
\documentclass[a4paper,10pt]{article}
\usepackage{lmodern}
\usepackage{amssymb,amsmath}
\usepackage{ifxetex,ifluatex}
\usepackage{fixltx2e} % provides \textsubscript

\usepackage[margin=1in,paperwidth=595pt,paperheight=841pt]{geometry}

\ifnum 0\ifxetex 1\fi\ifluatex 1\fi=0 % if pdftex
\usepackage[T1]{fontenc}
\usepackage[utf8]{inputenc}
\else % if luatex or xelatex
\ifxetex
\usepackage{mathspec}
\else
\usepackage{fontspec}
\fi
\defaultfontfeatures{Ligatures=TeX,Scale=MatchLowercase}
\fi
% use upquote if available, for straight quotes in verbatim environments
\IfFileExists{upquote.sty}{\usepackage{upquote}}{}
% use microtype if available
\IfFileExists{microtype.sty}{%
\usepackage{microtype}
\UseMicrotypeSet[protrusion]{basicmath} % disable protrusion for tt fonts
}{}
\usepackage[unicode=true]{hyperref}
\hypersetup{
pdfborder={0 0 0},
breaklinks=true}
\urlstyle{same} % don't use monospace font for urls
\IfFileExists{parskip.sty}{%
\usepackage{parskip}
}{% else
\setlength{\parindent}{0pt}
\setlength{\parskip}{6pt plus 2pt minus 1pt}
}
\setlength{\emergencystretch}{3em} % prevent overfull lines
\providecommand{\tightlist}{%
\setlength{\itemsep}{0pt}\setlength{\parskip}{0pt}}
\setcounter{secnumdepth}{0}
% Redefines (sub)paragraphs to behave more like sections
\ifx\paragraph\undefined\else
\let\oldparagraph\paragraph
\renewcommand{\paragraph}[1]{\oldparagraph{#1}\mbox{}}
\fi
\ifx\subparagraph\undefined\else
\let\oldsubparagraph\subparagraph
\renewcommand{\subparagraph}[1]{\oldsubparagraph{#1}\mbox{}}
\fi

\date{}
```

\begin{document}

\subparagraph{\large Detailed Photoionization Analysis of Chemodynamical Simulation
Results for the Evolution of Dwarf Star-Forming Galaxies at an Age of
100
Myr}\label{photoionization-analysis-of-chemodynamical-simulation-results-for-the-evolution-of-dwarf-star-forming-galaxies-at-an-age-of-100-myr}

\vspace{0.2cm}

\textbf{Authors}: M. Shevchenko^{1}, B.
Melekh^{1}

\emph{^{1}Ivan Franko National University of Lviv,
Kyrylo \& Methodiy str. 8, 79005 Lviv, Ukraine}

\vspace{0.2cm}

During the modification of multicomponent photoionization models (MPhM)
of nebular emission surrounding regions of active star formation,
developed to analyze chemodynamical simulations of the evolution of a
dwarf galaxy characterized by intense star-forming activity (which account for
the age-dependent variations in chemical abundances, gas density, and
temperature within the "superwind" region), a significant problem arises
related to the treatment of the diffuse ionizing radiation (DIR) field
within the nebular environment. Typically, the \emph{Outward-only}
approximation is employed for this purpose {[}1,2{]}. However, the
inhomogeneous ionization structure of the nebular medium, as revealed by
chemodynamical simulations of these objects, suggests that the presence
of an ionization front in the equatorial sectors of the dwarf galaxy may
be a numerical artifact caused by incorrect DIR calculation. In [3], a procedure for the detailed
calculation of DIR within the framework of multicomponent
photoionization modeling was proposed. The authors
applied this method to an MPhM corresponding to an evolutionary age of
140 Myr. As expected, the resulting ionization structure in the
equatorial sectors differs substantially from the one obtained using the
\emph{Outward-only} approximation.

In the present work, we compare the results of MPhM for an evolutionary age of 100 million years. The
initial spatial maps of emissivity and opacity (MEO) for a wide range of photon energies
(both continuum and line emission) were obtained
using the \emph{Outward-only} approximation with the Cloudy code
{[}4{]}. These maps were subsequently used for a detailed calculation of
the DIR field using the DiffRay code
{[}3{]}. The updated MEOs were then employed to recalculate the MPhM
using the Cloudy code, taking into account the DIR field precomputed by
DiffRay. As a result, the obtained ionization structure differs
significantly from the initial one (derived under the
\emph{Outward-only} approximation),
underscoring the necessity of
further Cloudy + DiffRay iteration cycles. Here we present the resulting ionization structure obtained after
the second global iteration.

\vspace{0.2cm}

\begin{enumerate}
\def\labelenumi{\arabic{enumi}.}
\item
B. Melekh, S. Recchi, G. Hensler and O. Buhajenko, Photoionization
analysis of chemodynamical dwarf galaxies simulations, MNRAS 450,
111--127 (2015).
\item
B. Melekh, S. Recchi, G. Hensler and O. Buhajenko, Erratum:
Photoionization analysis of chemodynamical dwarf galaxies simulation,
MNRAS 502, 1048--1050 (2021).
\item
B. Melekh, O. Buhajenko, I. Koshmak. Photoionization analysis of
chemodynamical dwarf galaxies simulations. II. Detailed calculation of
diffuse ionizing radiation, MNRAS 532, 524--537 (2024).

\item
G. Ferland, Hazy, a Brief Introduction to Cloudy, Version 08
(University of Kentucky Internal Report, 2008), 807 p.
\end{enumerate}

\end{document}

Primary authors: SHEVCHENKO, Mykhailo (Ivan Franko National University of Lviv); Prof. MELEKH, Bohdan (Ivan Franko National University of Lviv)

Presenter: SHEVCHENKO, Mykhailo (Ivan Franko National University of Lviv)

Session Classification: Astrophysics and Cosmology

Track Classification: Astrophysics and Cosmology